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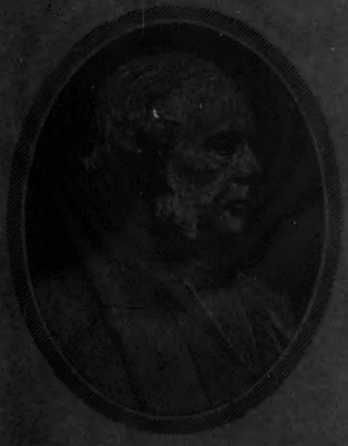

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THE
BRITISH JOURNAL OF SURGERY

VOL. XXXIV APRIL, 1947 No. 136

INJURIES OF PERIPHERAL NERVES IN TWO WORLD WARS*

BY W. ROWLEY BRISTOW

SYNOPSIS

1. The influence of Robert Jones on the surgery of peripheral nerves.
2. The position of peripheral nerve surgery before 1914, during the 1914–18 war, and in the years which immediately followed. The lessons learned.
3. Surgery in the 1939–45 war, with analysis of 2600 cases. Primary and secondary suture. The organization. Method of recording neurological recovery in sensation and motor power—sponsored by the Medical Research Council.
4. Survey of results of sutured nerves: January, 1941–January, 1946. Nerve-grafting—the present position. Reasons for imperfect results.
5. Functional results and lessons to be carried into civil practice.

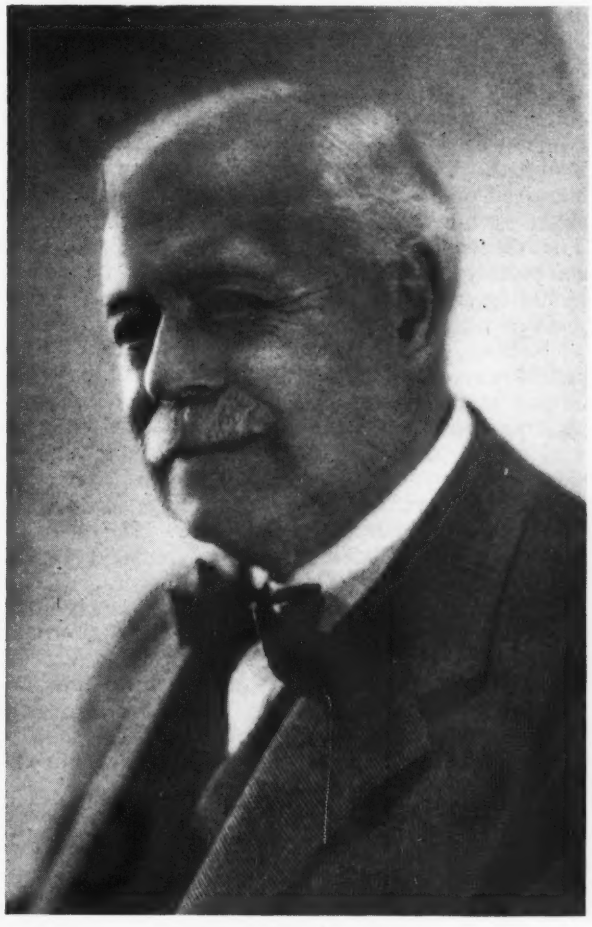
INTRODUCTORY

Robert Jones, in whose honour this Lecture was founded, died in January, 1933, nearly fourteen years ago, and I would like to commence by recalling to your memory something of the man and his work. The whole story of his life is told in a beautifully written biography by his son-in-law, Frederick Watson (1934). Watson wrote with knowledge and understanding, and his book is a delight to read.

Qualified at the age of 21, Jones joined his uncle, Hugh Owen Thomas, who was carrying on an enormous practice in the dock area of Liverpool, at 11, Nelson Street. This warren of a house, consisting of numbers of small rooms and cubicles, was a Mecca for surgeons, especially those from the States and from the Continent. It was totally destroyed in the 'blitz' on Liverpool in the spring of 1941, and is replaced by a heap of rubble, and all the interesting records are lost.

Jones learned the principles and practice of surgery from Thomas, and serves as an outstanding example of the great advantages of the old system of apprenticeship, where his opportunities were never ending for acquiring all that the master had to teach. He made the most of these opportunities, and he did what Thomas could never do, he made those principles and that practice part of British surgery.

At the age of 31 he was appointed Surgeon-Superintendent, to organize and control the chain of hospitals which were improvised to provide an accident hospital service for the great industrial undertaking, the building of the Manchester Ship Canal. Some 20,000 navvies were employed. In retrospect this appointment was providential, for



SIR ROBERT JONES

when the opportunity came with the war of 1914–18, he was fitted by knowledge and experience, as well as by temperament and personality, to play the great part which he did play in the care of the wounded soldier.

When, by the late autumn of 1914, our casualties were enormous and the wounded were crowding into the home hospitals from the Battle of the Marne,

* Being the Robert Jones Lecture delivered at the Royal College of Surgeons of England on Dec. 12, 1946.

following the Mons retreat, from the Aisne and from Ypres, Jones saw the problem in its entirety and found the solution in the formation of the Orthopædic Centres. Writing in defence of these later to Makins, he says :—

> During the first twelve months of the war no provision of any sort was made for cases crippled and deformed, and early evacuation was both the instruction and the routine. The result was that many men were discharged from the Army in a very large number of cases totally unfitted either for military or civilian life. These men promised to become foci of seething discontent and at that time a menace to successful recruiting.

Sir Alfred Keogh, the then Director-General, sent for Robert Jones and it was arranged that 250 beds should be allocated to him in Alderhey in Liverpool as a trial. Shepherds Bush opened in the spring of 1916 and finally some 30,000 beds were set aside in the Orthopædic Centres, and patients were not discharged until all that could be done for them was done.

For patients to be segregated into the Orthopædic Centres, it was essential that the type of disability comprised within the term must be defined. In addition to fractures and diseases and injuries of joints, peripheral nerve injuries were included. This was a wise inclusion, for operation, if indeed operation is called for, is but an incident, albeit an important one, in the care of the patient. The Centres, with their long-stay privilege, their complete physiotherapy and rehabilitation sections, including curative workshops, were well staffed by a team of which a neurologist was a key member.

Robert Jones's influence on the problem of peripheral nerves was first and foremost, then, in organization and planning for the segregation of these patients under a staff equipped to deal with them.

He had always been interested in the clinical side, and in 1906, with Warrington, of Liverpool, had published in *The Lancet* a paper entitled " Some Observations on Paralysis of the Brachial Plexus ", and gave the opinion that mechanical treatment should be thoroughly persevered with before having recourse to operation. In this paper the literature is reviewed, and there are many references to the work of Sherren, Kennedy, and Spitzy of Vienna. Nerve transplantation, anastomosis, and grafting are discussed.

An interesting sidelight on his early association with Thomas is forthcoming when he outlines the after-treatment of these injuries.

He writes :—

> The muscle should be systematically and energetically massaged. In the case of the poor who cannot afford a masseur, a small gutta-percha ball transfixed by a skewer and placed in a handle will render good service.

His interest was largely centred in the somewhat similar problem of infantile paralysis. He preached and practised and taught the need for relaxation of paralysed muscles by appropriate splintage, the need to avoid deformity caused by the continued action of the non-paralysed opponents or by gravity. In order to bring home the lesson he stressed that never for a single moment must the paralysed muscle be stretched—splintage must be efficient, prolonged, and constant.

Then again he contributed to the problem of the means for restoration of function when the paralysis is permanent. His experience was unique among his contemporaries, and much of the work was but little known outside Liverpool. Jones's pre-war reputation was far greater both in the States and on the Continent than in his own country, and his great ability far more appreciated. It is fair to say that not until the war did he take his rightful place as an acknowledged leader of British surgery, and the master in that field which he had made his own. Of the many operations he designed and practised, perhaps the complete tendon transplantation for musculospiral palsy has the greatest vogue at the present day.

In 1919, when visiting the States with Anthony Bowlby, he presented a paper to the Clinical Congress of the American College of Surgeons (1920) entitled " Joint, Nerve, and other Injuries in War Surgery ", and his review of the treatment of peripheral nerve injuries is clear, concise, and accurate.

As one who by force of circumstance has been very much concerned with the problem of peripheral nerve surgery in the two wars, I have chosen this subject for the Robert Jones Lecture.

Previous to the war of 1914–18 there was but little helpful literature on the surgery of peripheral nerves, the outstanding contributions being Weir Mitchell's *Injuries of Nerves and Their Consequences* (1872) and Sherren's monograph, published in 1908, as the result of his work with Head. It will be remembered that Sherren divided and sutured Head's radial nerve, and partly as the result of this human experiment, Head's theory of cutaneous sensation was formulated, based on his conception of epicritic, protopathic, and deep sensibility. These terms were in common use and appear in the voluminous literature on the subject which followed the war years.

The term protopathic has been finally discarded. I do not propose to enlarge on the theories of cutaneous sensibility, as this has been done in a brilliant review by Walshe, published in *Brain* (1942), in which he discusses the various reasons which render Head's theory untenable. Head postulated a second set of sensory nerves which had no foundation in any known structure, and the work of Woollard and later of Weddell on the anatomy of the sensory nerves finally assisted to disprove his theory.

Charles Ballance and Purves Stewart had also written on the subject, and Ballance's work on facio-hypoglossal anastomosis is well known. Kennedy, of Glasgow, had operated on a considerable number of birth injuries of the brachial plexus and was somewhat more optimistic than his contemporaries or the later generations of surgeons.

But viewed broadly, peripheral nerve surgery was a new and largely unexplored field ; there was little authentic information obtainable, and still less knowledge of what was to be expected in the way of end-results.

As already told, when discussing Robert Jones's work and influence, by 1916 the wounded with peripheral nerve injuries were segregated and dealt

with in selected centres, as part of the orthopædic organization which he founded and controlled. In addition to one's colleagues in the orthopædic group of that time, there are names to be remembered in connexion with this—amongst others, one may mention Stiles, of Edinburgh, Wilfred Trotter, Percy Sargent, and Joyce, of Reading. Wood Jones's (1921) description of trick movements and Stopford's review (1920) of intermediate results, were noteworthy contributions.

In 1920 the Medical Research Council published *The Diagnosis and Treatment of Peripheral Nerve Injuries*, compiled by the Committee upon Injuries of the Nervous System, under the Chairmanship of Farquhar Buzzard. This report was reprinted in Canada in 1942, and is still the standard work on the subject. The other outstanding contribution is the section on operative treatment, written by Stiles, in Jones's *Orthopædic Surgery of Injuries*, published by the Oxford University Press in 1922,

It will be remembered that Stiles was a superb anatomist and had written the section on surgical anatomy in 'Cunningham.' His detailed description of the surgical approaches and exposure is masterly, as witness the exposure of the sciatic at the notch by reflection of gluteus maximus from below upwards, the finding of the radial nerve between brachio-radialis and brachialis anticus by tracing the cutaneous branch upwards until it joins the parent trunk, or the retraction of the neuro-vascular bundle medially in exploring the radial as it enters the humeral groove.

In 1923 Professor Harry Platt and I were detailed to present the British Report on this subject at the International Society of Surgery, at its meeting in London. The available statistics were somewhat meagre, and there is no statistical record of the results of the vast number of patients who were operated upon. No late follow-up showing true end-results on a large scale was possible.

In the main our conclusions, which were based largely on impressions, have proved to be correct. End-to-end suture was stressed as the one operation likely to yield results when operating on a divided nerve. Various operations for overcoming a gap, described and illustrated in the text-books of the time, were tried and finally condemned—amongst others in this category may be mentioned :—

Neuroplasty, or the turning down of a flap from the proximal to the distal stump.

Tubulization, the joining of the divided ends by a sheath of fascia, vein, or some foreign material such as Cargile membrane.

Nerve-grafts, which, although in a few instances they showed some degree of recovery, were in the main failures.

The final assessment of the value of nerve-grafts in the 1914 war was that if no other means of joining the nerve was practical, a graft should be employed. If a graft was used then an autogenous cable graft was advised.

I shall refer to the present position regarding nerve-grafts when considering the 1939–45 war, but at that time there was a general impression that a graft was an alternative to suture, and both homogenous and heterogenous grafts were employed. It seemed necessary to stress the point that the surgeon must exercise all his ingenuity to endeavour to join the nerve end to end and that grafting was not an alternative operation but only to be used as a last resort.

In the final survey it was pointed out that neurological recovery always fell short of perfection—generally a very long way short, but that the result of nerve suture, viewed from the standpoint of function, gave reasonable results in many instances.

The pre- and post-operative treatment, and the treatment of the lesion recovering without operation, was systematized. We learned the importance of preserving joint mobility, especially that of the smaller joints in the hand and foot, a lesson which definitely had to be re-learned in 1939. We learned, too, the methods of overcoming fixed deformity. This was comparatively simple in the bigger joints, but was difficult in the hand. We learned that forced manipulation under anæsthesia followed by activity was useless for the stiff metacarpo-phalangeal range, or for the joints of the fingers. Many ingenious devices were implemented by elastic or spring traction, by wedging with malleable splints, or by the use of plaster for overcoming fixed deformity in these small joints. Splints were used to relax paralysed muscles, the shoulder abduction splint in plexus injuries and the "Shepherds Bush glove" for radial nerve palsy (*Figs.* 484–487). A toe-raising spring replaced the paralysed dorsiflexors of the foot in lateral popliteal paralysis. Splintage, however, was minimal, always provided the principle that the paralysed muscle must be held relaxed was followed.

The after-treatment by physiotherapeutic methods was carried out efficiently and more continuously than in the war of 1939. Heat, massage, interrupted galvanic stimulation, and finally, with recovery, faradism and exercises were the general routine. It was clearly stated that although these measures had no effect on regeneration of nerve, they preserved and kept up nutrition in the limb.

There is a difficulty in practice in carrying out this programme of rehabilitation. It is easy so long as the man is in hospital or convalescent centre. In Shepherds Bush and its annexes many of these men remained for months and spent their time in the curative workshops attending the specialized therapy departments for daily treatment. The man-power shortage did not appear as extreme as in the 1939 war, and I am under the impression this time that there is less specialized physiotherapy and that the men go back to a trade or to work and avoid daily visits to treatment centres.

Whether they, in fact, lose much by so doing is hard to say. The value of interrupted galvanism must be weighed against the economic factor—the loss of time and work during their attendance or in transit to hospital or clinic. Galvanism seemed to make for less wasting and the experimental work of Guttmann and others suggest that the wasting is definitely less. Again, galvanic stimulation had some value on the psychical side because for a patient to see the paralysed muscle in action and the joint moved by his own muscle is a stimulus. Therefore, my personal view would be that there should be careful selection of patients and that some who are keen to work and whose functional disability is

minimal, as with a low ulnar lesion, should be encouraged to work, and that for them prolonged after-treatment is unnecessary. There is much that they can do in productive industry or even in the Services if the man-power position demands it and reinforcements are few, as at times in the Middle East.

The various operations to improve function in dealing with the problems afforded by irreparable nerve lesions were based on, and are similar to, those already practised in the treatment of the disabled limb following infantile paralysis. Robert Jones was a pioneer in this work. His tendon transplantation for radial nerve palsy will be discussed when we are considering the results of suture of that nerve, and is still the standard practice.

Tenodesis, e.g., converting the paralysed dorsiflexors of the foot into a suspensory ligament, for paralysis of the lateral popliteal was tried, but abandoned as the newly-formed ligament stretched and allowed the foot again to drop.

Certain other simple procedures, such as Bier's subcutaneous elongation of the tendo Achillis for fixed equinus, and excision of a dorsal bone wedge for fixed flexion deformity of the interphalangeal joint of the great toe, a not uncommon consequence of a divided sciatic, were practised and still have their place in reconstructive surgery.

These, then, are some of the lessons we learned in the 1914–18 war and, like other happenings of that time, they had to be, in part at least, re-learned when peripheral nerve surgery again became a major problem some twenty years later. The failure of that period, if one may use the term, lay in the poorness of the note-taking and recording and the difficulty of obtaining a long enough follow-up of the patients.

Looking back and comparing the surgery of the war of 1914–18 and of the years which immediately followed with the surgery of the present war, it is doubtful whether there has been any great advance in technique or in operative skill which would lead us to expect an improvement in results.

FIG. 484.—Shepherds Bush glove, with elastic accumulators replacing extensor tendons. Extended position.

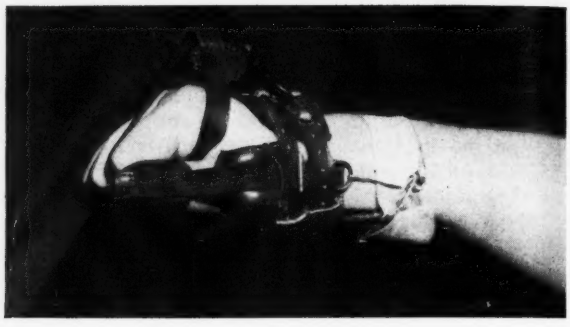


FIG. 485.—Flexed position.

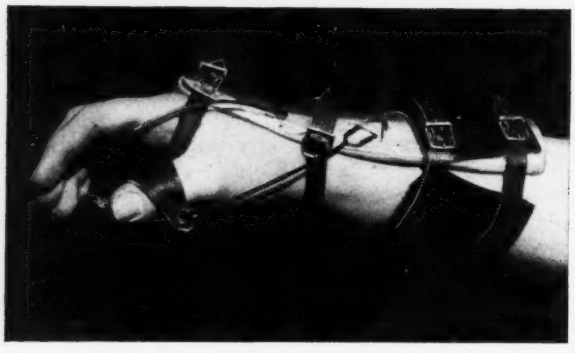


FIG. 486.—Brian Thomas modification of *Fig.* 484, extended position. Note finger-tips are uncovered.

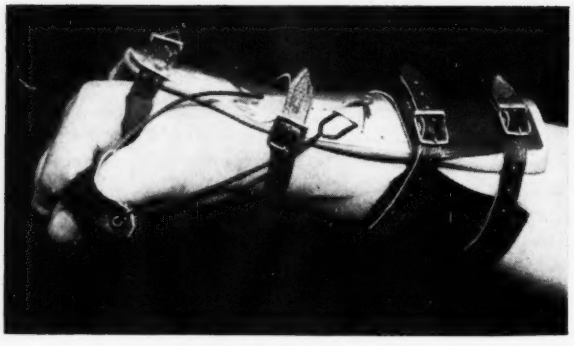


FIG. 487.—Flexed position.

Brief mention is called for in regard to certain advances which have been made. In a personal communication, Bauwens describes the advances in electrical testing as follows :—

> The excitability of muscles gives some useful indications as to the state of the muscles' innervation, and can, therefore, indirectly give information of diagnostic and prognostic value in motor nerve lesions.
>
> Quantitatively this excitability can be expressed as a curve called the intensity-duration curve.
>
> When dealing with a muscle in which all fibres have the same characteristics of excitability—all normal or all denervated—one or two points on this curve will give all the information necessary, particularly when the type of response is also taken into consideration (sluggish or brisk reaction to interrupted galvanism). In these cases investigation with faradism and galvanism suffices.
>
> When a muscle consists of a mixture of fibres with different characteristics of excitability—as in partial lesion or during recovery—the intensity-duration curve becomes the resultant of two curves.
>
> Recovery, which means an increase in the ratio of normal to denervated muscle-fibres, is indicated by a

modification of the shape of this resultant curve. It follows that the greater the number of measurements taken in order to plot the curve, the more reliable can be the deductions drawn.

In practice, the reconstruction of curves from three measurements of the current for durations of $\frac{1}{1000}$ of a second, $\frac{1}{50}$ of a second, and 1 second, proved adequate, without being technically tedious.

Table I.

(January, 1941, to December, 1945)

Total number of patients		2082
Total number of peripheral nerve lesions		2636
Nerves involved :—		
Brachial plexus	123	
Medians	451	
Ulnars	664	
Radials	321	
Dorsal interosseous	85	
Musculo cutaneous	21	
Axillary	25	
Internal popliteal	426	
External popliteal	520	

segregation and treatment of these patients. There are three main centres in England and two in Scotland, and the majority of the work has been carried out in these centres. The work done at one centre, that at Pyrford and Botley's Park, for the London area, is shown in *Tables I, II.*

A peripheral nerve injury, in war at least, is seldom an isolated lesion, for there is usually gross associated damage to muscle, tendon, blood-vessels, or bone. The injury, then, is a complicated one, and special experience of the surgery of the extremities is required by the surgeon handling the problem.

TECHNIQUE

I do not propose to enter into details of operative technique, and would only remind you that the lessons learned in the 1914 war were put into practice. These include the widest anatomical exposure, altera-

Table II.

(Jan. 1, 1941, to Dec. 31, 1945)

Operations	Suture	Neurolysis	Bulb Suture	Grafts	Irreparable	Tendon Transplantation
Median	114	58	2	2	3	—
Ulnar	212	53	—	—	8	—
Radials	57	21	—	—	23	30
Dorsal interosseus	4	—	—	—	—	16
Musculocutaneous	2	—	—	—	1	—
Internal popliteal	71	62	1	3	11	—
External popliteal	106	55	—	—	17	—
Total	566	249	3	5	63	46

The use of electromyography is another definite advance and yields information which cannot be obtained in any other way. Although not required in the ordinary routine examination, it must be available to solve a difficult problem. The sweat test also forms a valuable check and has been largely employed. In technique, the use of fibrinogen plasma as a suture material has a definite if limited value. Much work has been done on the histology and pathology in relation to the nerve gap and regeneration and many papers have been published, mainly from the Oxford Centre.

It is good to be able to say that during the 1939–45 war the Medical Research Council Committee, this time under the Chairmanship of George Riddoch, has not only systematized the note-taking and recording, but with the greatest co-operation from the Ministry of Pensions, has established an efficient follow-up system. The Ministry, to their lasting credit, have sanctioned payment both for travelling and lost working hours to the men who attend at the necessary intervals. By this means, a wealth of records of vast importance is being accumulated. The follow-up will continue till 1949, so that for many patients, at least, a five-year follow-up is envisaged, the man being seen and assessed at the centre nearest his home, and not necessarily at that at which he was treated originally. This serves as a useful check and disarms the criticism which might be levelled at a surgeon assessing his own results.

In the 1939–45 war, under the E.M.S., an organization similar to that of 1914 was planned for the

tions in posture of the limb, stripping up of branches, and transposition for the ulnar and rarely for the musculospiral. Bulb suture, the two-stage operation, and bone shortening will be needed at times, usually for the median or medial popliteal.

Suture of the sheath only with the finest thread or stainless steel wire is the general practice. The protection of the suture line by wrapping was tried in the 1914 war, and given up, and was not practised, as a rule, by our surgeons in the recent war. The Americans used tantalum foil as a protective wrapping and were enthusiastic as to its value. Certainly some of them have given it up and Stirling Bunnell states that he spends much time in removing it. Our experience is that any form of wrapping increases fibrosis round the nerve and is best avoided.

Primary and Secondary Suture.—The question of the advisability of primary suture has given rise to a great deal of discussion both in our own country and in the United States.

The problem seldom arises in war surgery. There is neither the time nor the equipment available to a surgeon in a Field Surgical Unit or a Casualty Clearing Station during an active phase. It is argued that even when both are available, it is better to delay. There are two main reasons for this advice: First, and more important, immediately following an injury, other than a clean cut with a knife, it is impossible to know how much of the nerve proximal to the point of division has been injured, and therefore the surgeon cannot know how much he should resect in order to expose healthy bundles. Secondly, the Schwann cells in the distal

stump, which play a considerable part in the union of the divided ends, take some time to exhibit maximum function. According to Young (1942) from about the second–third week is the optimum time. If a nerve is divided by a clean cut or inadvertently at operation it should be sutured immediately, as the damage to the proximal stump met with in wounds caused by high-velocity bullets or in severe crushes does not arise.

Spurling and Woodhall (1946) have published some figures bearing on this point. They record that they have found 22 per cent of failure in primary sutures, compared with only 5 per cent failure in the early secondary suture, but the follow-up is too short to be of any real value.

In the repair of a digital nerve, an important and fairly common operation in civil practice, primary suture will give the surgeon his one chance of affecting direct repair. The freeing and suture of a divided digital nerve in scar tissue following healing is generally impossible and autogeneous grafting will be called for as the alternative.

Early versus Late Repair.—The whole question of effect of the time-lag between the injury and suture is of interest. Most experienced surgeons advocate early intervention, and this has been the agreed policy in this country. The difficulty arises in carrying it out in practice. In an active campaign the overriding necessity for freeing hospital beds, for evacuation to the permanent base, coupled with the time lost in transport, impose a necessary delay. A patient may spend many weeks, with frequent change of hospital, before he finally reaches the centre.

But we, like the Americans, aimed at early intervention, and during the later part of the Italian campaign a peripheral nerve centre was opened in Italy at Caserta. There, 110 nerves were explored and 60 sutures were carried out with a delay of only some few days or weeks. These patients are being followed up as a group, but they were sutured too recently for inclusion in the present review.

Spurling and Woodhall (1946) have reported 1500 sutures with an average delay of 39 days from wounding. They claim that the nerves were more readily mobilized and that the scarring was minimal, making the operation easier of performance, and they stress the favourable condition of the nerve stump, and of the denervated muscles, shortly after injury.

It should be made clear that although there is some doubt about the relative values of primary and secondary suture, no one advocates delaying the operation of secondary suture, excepting for some very good reason such as the existence of an open wound or sinus. The M.R.C. Report of 1920 says: "... fortunately such delay has little appreciative effect on the ultimate result", and this statement is largely true. The report is sometimes misquoted or at any rate misunderstood (Cairns and Young, "Treatment of Gunshot Wounds of Peripheral Nerves", 1940), and has given rise to the opinion that delay in repair was considered a matter of no moment.

The follow-up of the sutured nerves from the 1939–45 war is of interest in this connexion. A comparison of the percentage of recoveries with delay of less than, and more than, six months, shows no difference, excepting with the ulnar and lateral popliteal, where the results appear slightly better following early rather than late secondary suture. It will be obvious that the earlier the suture is done, the less will be the wasting and general change in the limb, no matter how well looked after, and emphasis should be laid on the need for keeping up the nutrition and the joint movements during any period of waiting, however short this period may be.

With nerve lesions complicated by fracture, precedence should be given to operation on the nerve. It may be that internal fixation of the fracture can be safely carried out at the same operation, but apart from this the fracture can be taken care of. An important reason for the policy of attacking the nerve without waiting for the healing of the fracture is that bone shortening may enable the surgeon to effect an end-to-end suture which would be impossible otherwise. To shorten a *fractured* humerus or femur is simple. To shorten an intact femur, united after months of treatment is a formidable undertaking, at least for the patient.

Neurolysis, or the freeing of the nerve from scar tissue, is the usual accompaniment of any nerve exploration which does not end in suture. The results of this operation recorded in figures or graphs are valueless. In the vast majority the operation makes no difference to recovery. If the nerve goes on to partial or even complete recovery, the result will be assessed in the various tables at a proportionately high percentage, but in all probability recovery would have gone on as completely without operation. In my experience, this operation is of value to relieve pain, when a nerve is anchored about a joint and when each movement of that joint exerts traction on the nerve so fixed. With such patients, the freeing of the nerve-sheath from scar and replacing it in a good muscle bed will generally yield the required result.

It must be remembered that with the syndrome of complete division and a wound in the anatomical course of the nerve, exploration should be regarded as part of diagnosis. If the surgeon finds the nerve intact—physiological division—no harm is done. It is not wise to wait for signs of returning function, and to explore only if these fail to appear.

RESULTS

The Peripheral Nerve Committee of the Medical Research Council are analysing the results so far obtained in the 1939–45 war, and it is by the kindness of my colleagues on this Committee that I am able to give you some figures derived from the five centres in addition to those of our own centre at Pyrford, from which certain conclusions as apart from impressions may be arrived at.

Anyone who attempts to produce tables and percentages will find he is up against a task of real difficulty. A table by itself showing results good, fair, or poor, is of no value. We must know, and know with some accuracy, the criteria for the findings.

The Medical Research Council criteria for sensory and motor recovery are used in all the centres, so that the records conform to a set standard (*Tables III, IV*).

It is intended in this review to illustrate the degree of recovery in individual nerves in composite

histograms, combining motor and sensory recovery in percentages.

To demonstrate the method we have used in arriving at the composite tables, we will examine

Table III.—Assessment of Sensory Recovery

S.o.	Absence of sensibility in the autonomous zone.
S.1.	Recovery of deep cutaneous pain sensibility within the autonomous zone of the nerve.
S.2.	Return of some degree of superficial cutaneous pain and touch sensibility within the autonomous zone of the nerve.
S.3.	Return of superficial cutaneous pain and touch sensibility throughout the autonomous zone, with disappearance of any over-response.
S.4.	Return of sensibility as in Stage 3, with the addition that there is recovery of 2-point discrimination within the autonomous zone.

the histograms of high median division one year after suture (*Fig.* 488) and trace recovery in two or

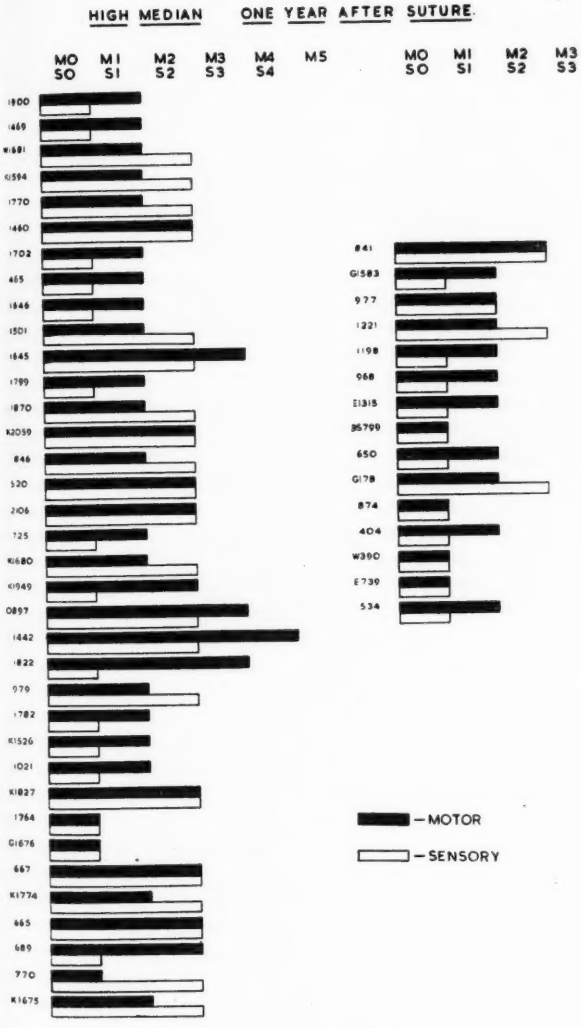


FIG. 488.—Results of high median suture one year after.

three of these patients for 2, 3, and 4 years after suture (*Fig.* 489).

Thus it will be seen that recovery may go on even between three and four years from the date of suture.

It will be noted that recovery may reach a point, perhaps quite early, and then remain stationary, and this holds good for either the motor or the sensory.

Table IV.—Assessment of Motor Recovery

M.o.	No contraction.
M.1.	Return of perceptible contraction in the proximal muscles.
M.2.	Return of perceptible contraction in both proximal and distal muscles.
M.3.	Return of function in both proximal and distal muscles of such an extent that all important muscles are of sufficient power to act against resistance.
M.4.	Return of function as in Stage 3, with the addition that all synergic and isolated movements are possible.
M.5.	Complete recovery.

In assessing the degree of recovery after repair we must make a clear distinction between two standards, the physiological or neurological on the one hand, and the functional or economic on the other. The former represents the degree of restoration of conductivity in the nerve estimated in terms of sensation and motor power, and it will be seen that this falls a long way below normal.

In general, it may be stated that the average successful result of suture is restoration of voluntary power in the proximal muscles, and recovery of sensation to pain as elicited by pin-prick and some appreciation of touch. Accurate and localized appreciation of light touch and compass-point discrimination are uncommon and voluntary control

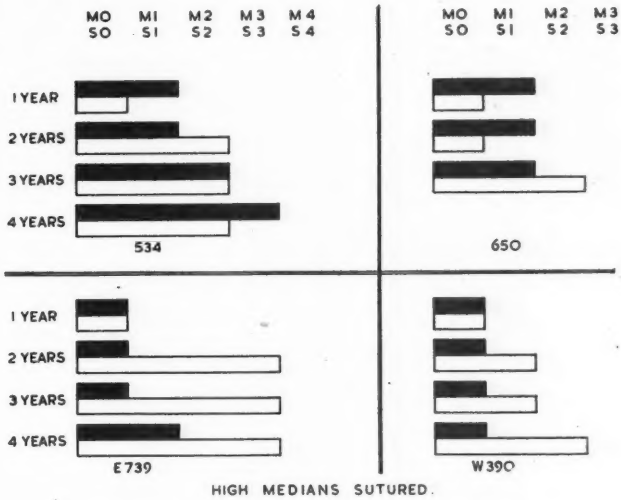


FIG. 489.—Results in cases of high median suture over a period of 4 years.

of the small muscles in the hand is also uncommon, whilst recovery of the foot intrinsics is practically unknown.

Thus M.1, S.2 on the table is a common finding. But even this table, worked out after considerable care, is not sufficiently informative. M.1 represents a return of perceptible contraction of proximal muscles *only*, M.2 a flicker in distal muscles as well. In many instances the proximal muscles recover good power, sufficient to act and move the limb against gravity and resistance, and yet there is no recovery in the distal muscles. Therefore we use

the term M1/3 in our records, meaning good function in proximal muscles, no recovery in the distal, and this formula will be seen in our composite tables.

Our percentage figures are not strictly comparable with those of the M.R.C. series, because we are assessing neurological recovery to a certain level of useful function instead of pure neurological recovery.

Any estimate from the angle of function must vary with the individual patient and the particular nerve involved. Thus a workmen, e.g., a bricklayer, may have good function, whilst still exhibiting the syndrome of the complete division of the ulnar nerve in the forearm. A violinist who has made average or above average recovery following suture may well be 100 per cent failure judged from the economic standard. Similarly an irreparable lesion of the lateral popliteal will put an end to the patient's career as an athlete, as a professional footballer or cricketer, but will be no disability to a man in a sedentary occupation.

RESULTS OF SUTURE

It will be convenient to summarize the results under the more important individual nerves, and it has been shown that early signs of recovery are no criterion that recovery will progress.

The best results are seen in children, when the small muscles will recover and something like perfection may be reached.

Considering the main nerves individually, we will begin with the most promising, the radial.

Radial Nerve.—The radial nerve in this war, as in the last, heads the list of recoveries, depending as it does on motor recovery almost entirely (*Fig.* 490).

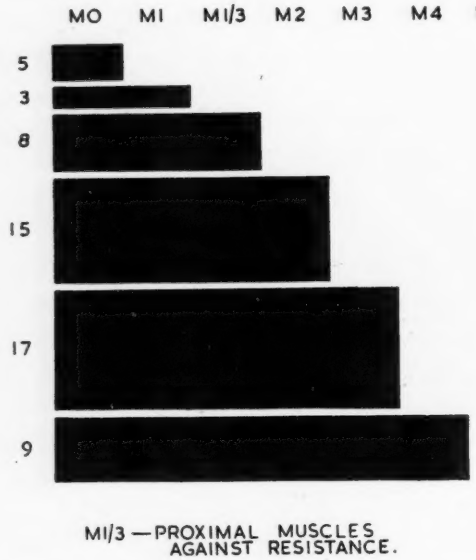


FIG. 490.—Motor recovery in 57 radials sutured over one year.

Of 57 radials sutured at Pyrford, 24 were high sutures—that is, in the groove in the humerus or above—and 33 were low sutures. Following the high suture, recovery will not be evident until over a year from operation, and if an assessment is made earlier, the result will be recorded as a failure, whereas such a patient may go on to adequate recovery. Of 57 sutures, 49 show adequate recovery or better.

Our high sutures gave 83 per cent successes, 17 per cent failures
Our low sutures gave 97 per cent successes, 3 per cent failures

Now this figure looks, on the face of it, too good, but 23 divided radials were regarded as impossible to suture. Put differently, whereas repair of a median is essential to restore sensation in the hand, fingers, and thumb, with a divided radial a tendon transplant is a good alternative and gives a useful hand, so we have not sutured the nerve unless we could get reasonably promising ends.

Radial nerve involvement is a common complication of a fractured humerus, open or closed.

Of 272 radials, 171 were accompanied by fracture (*Table V*). Some of these were involved to a minor degree, and indeed 120 recovered spontaneously. With a closed fracture anatomical division of the nerve is rare, and it is wiser to await signs of recovery rather than to explore early.

Table V.

	Closed	*Open*	
Radial nerve lesions accompanied by fracture			171
Recovered spontaneously	17	103	
Sutured	7	25	
Tendon transplant	2	17	
Dorsal interosseous lesions accompanied by fracture			38
Recovered spontaneously	6	21	
Sutured	—	2	
Tendon transplant	—	9	

Tendon Transplant for Irreparable Radial Nerve Lesion.—The classical operation designed by Robert Jones is still the routine. I would remind you that he transplanted P.R.T.→ E.C.R.L. — F.C.R. into E.C.R.B.
E.O.M.P. and E.B.P. and F.C.U.→ the finger extensors and E.L.P.—sometimes palmaris longus was used instead of F.C.R.

This operation gives a good useful hand, with controlled extension of the wrist and fingers, but Zachary (1946) has pointed out that the results are far better if one wrist flexor is present. The standard operation then suffices if the patient possesses a palmaris longus, which stabilizes the wrist when the fingers extend. In those in whom the palmaris longus is absent, Zachary employs F.C.U. for all extensors, including the thumb, leaving F.C.R. as a stabilizing muscle to fix the wrist.

One flexor to prevent the wrist from dorsiflexing is of considerable value, and its absence may account for the variations in result sometimes seen. In a sample taken at random of 100 males and 100 females, the palmaris longus was present on both sides in 81 per cent. It was present in right arm only in 4 per cent and in left arm only in 6 per cent. Therefore 8 per cent of patients had no palmaris longus on either side (*Table VI*).

Table VI.—PALMARIS LONGUS

	Men	*Women*
Present both sides	80	82
Present right only	5	3
Present left only	6	7
Absent both sides	9	8
	100	100

Total—Both present	81	per cent
Right present only	4	per cent
Left present only	6·5	per cent
Both present	8·5	per cent
	100	per cent

In those with palmaris longus absent the wrist will dorsiflex as the fingers and thumb extend, and this interferes with function in certain movements.

Median Nerve.—The degree of recovery shown by the median after suture is better than one expected —always remembering that neurological recovery falls far short of normal.

Of 51 high median sutures in the arm, 31 (61 per cent) resulted in adequate motor and sensory recovery (*Fig.* 491).

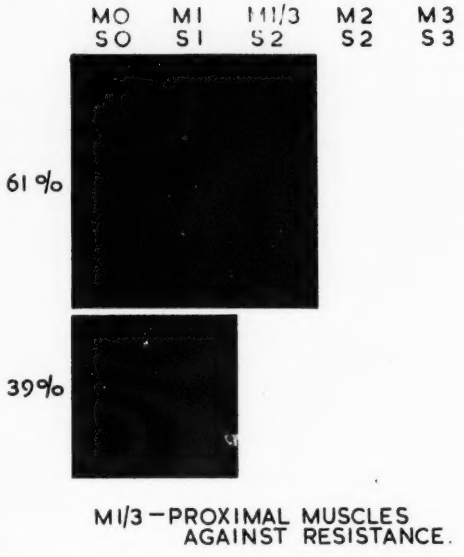


FIG. 491.—Recovery in 51 high medians sutured over one year.

Of the 47 low medians, 30 (64 per cent) reached this grade. It is difficult to estimate motor recovery following a low suture (*Fig.* 492). The anatomical

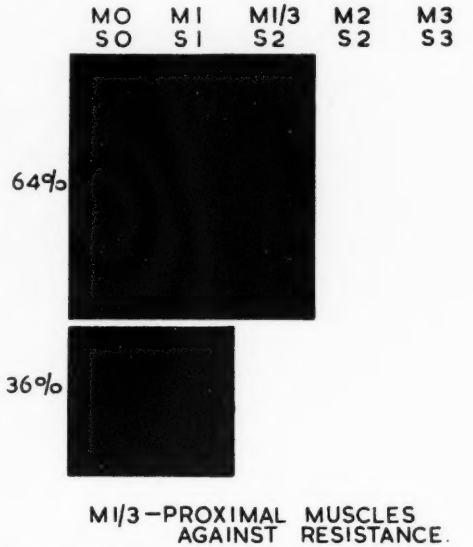


FIG. 492.—Recovery in 47 low medians sutured over one year.

variations in the motor supply to the small muscles of the hand are more common than was thought. The most extreme example was reported to me by Weddell (1946). A patient with complete division of the ulnar had the nerve sutured in the early days of penicillin. On his return to this country shortly afterwards, he was found to have normal function in all the hand intrinsics, which gave rise to much speculation. However, on blocking the median, all intrinsics were paralysed, and the anatomical variation in supply made evident.

We can say that rather more than half the median sutures, high or low, are successful, in so far as the results are compatible with a safe hand. Of the total of 91, 10 only recovered nearly normal sensation —that is, had no over-reaction.

From the point of view of function, recovery of sensation in the median is all important. A 'safe' hand from the standpoint of cutaneous sensibility means that the patient can appreciate pain, and therefore will no longer be liable to burns from his cigarette or allied injuries. This is something gained, but recovery to this level only leaves the hand much disabled. Most men with a median nerve injury use the opposite hand for common domestic acts, such as doing up a button. They are unable to feel the milled edge of a coin, and they carry their money in their opposite pocket. They rely on the uninjured hand when one hand will suffice for what they are doing.

A divided median, then, will surely leave some degree of permanent disablement and it may well be a severe degree.

Ulnar Nerve.—The ulnar, with a far smaller autonomous sensory area, is a less severe handicap to the majority when injured than the median.

The M.R.C. figures of recovery following suture of this nerve, with a minimum follow-up of over twelve months and a maximum of three years, show that of 391 sutured ulnars 30 per cent recovered some power in the proximal and distal muscles, more than a flicker of contraction in the 1st dorsal interosseous, but not sufficient to act against gravity and resistance; 13 per cent recovered to good power in all muscles; and 5 per cent were practically normal (*Fig.* 493).

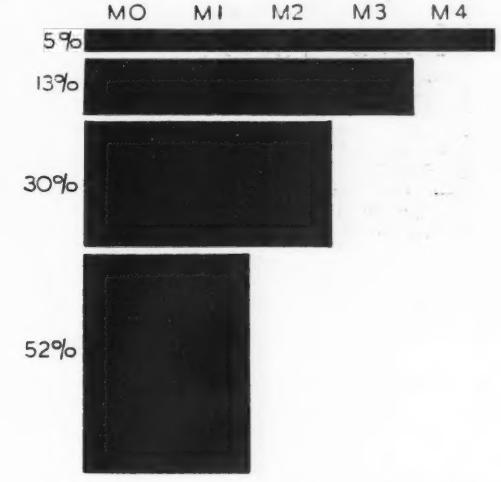


FIG. 493.—Motor recovery in 391 ulnars sutured over one year.

Of 383 sutures, 57 per cent recovered sensation to S.2 or better, which I would remind you means "return of some degree of superficial cutaneous pain and touch sensibility within the autonomous zone" (*Fig.* 494).

The figures from our centre show combined motor and sensory recovery in a composite graph, and are divided into high and low sutures. Of the 88 high, 49 per cent reach M.1/3, S.2 or better, that

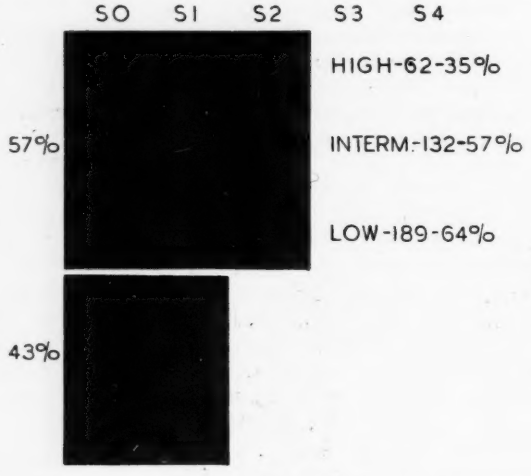


FIG. 494.—Sensory recovery in 383 ulnars sutured over one year.

is adequate recovery; 51 per cent reach M.1, S.1 and are failures, at any rate at present. Some of these, it is fair to say, may show improvement after a further interval (*Fig.* 495). Of the 104 low, 55 per cent are adequate (*Fig.* 496).

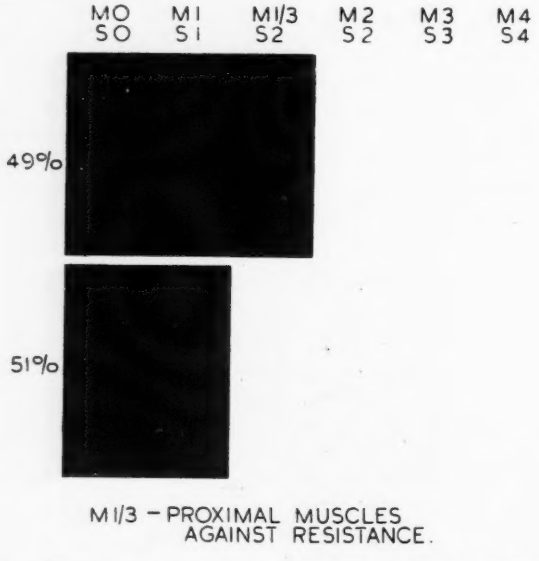


FIG. 495.—Recovery in 88 high ulnars sutured over one year.

The disability resulting from a divided ulnar depends on the occupation of the patient. Many men with no recovery are able to carry on full work and heavy work, such as dock labouring and bricklaying, but when the finer control is needed, as in playing a musical instrument, the patient is seriously handicapped. Equally, precision work such as operating a machine tool will be impossible.

Full neurological recovery is not seen, although a successful suture in a clean cut about the wrist, especially in a child, may result in the restoration of voluntary power in the interossei.

The Sciatic.—I cannot do better than quote the generalization from our paper (Platt and Bristow, 1924):—

> Here the neurological and economic results have been consistently poor. No case is on record where recovery has been demonstrated in the intrinsic muscles of the foot. The type of sensory restoration has been on the average exceedingly defective, and this has constituted in many patients a source of danger from the tendency to the development of traumatic ulceration in the foot. The earlier and more complete recovery seen in the calf muscles, as compared with the anterior tibial group, has often been instrumental in determining the production of a contracture in patients who have lacked post-operative supervision. As in the case of the median nerve, irritative phenomena are occasionally seen, and add to the serious psychical and physical disablement of the individual.

This summarized the results of 1914–18 and is a fair summary of the results we are seeing now.

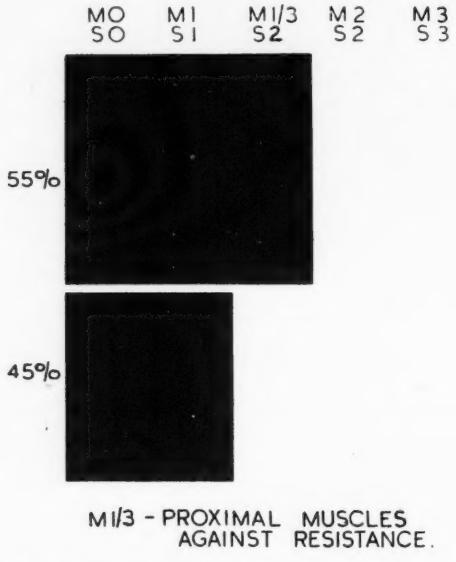


FIG. 496.—Recovery in 104 low ulnars sutured over one year.

It is important to assess ultimate function, because in practice the problem arises: Is this man better off with a below-knee amputation? If sufficient time has elapsed since suture, and there is little or no recovery of sensation in the medial popliteal distribution, if the man has a thin wasted foot, with ulcers, and can neither walk any distance nor stand at a bench, amputation will be called for. A good below-knee stump and a well-fitting artificial limb is not a crippling disability. It permits of good function, of walking any reasonable distance, and of standing at work. These men do not lose working days. There are many patients with partial recovery following suture who would be better off with an amputation, and this is even more to be advised when there is the complication of a vascular lesion and some added ischæmia.

It is of interest that some patients with no neurological recovery have good function, and it is the estimate of the functional state on which the decision must be made.

In assessing the results of suture from the neurological standpoint, the sciatic is best considered under its two divisions, the medial and the lateral popliteal. The M.R.C. analysis is made in this way, and the results are as follows. The figures are taken from the five centres with a minimum follow-up of twelve months for the motor and of two years from the time of suture for the sensory.

Medial Popliteal.—Of 109 sutures, 49 per cent showed recovery of *voluntary* power in the calf, and 51 per cent some pain *sensibility* in the foot (*Figs.* 497, 498), but motor and sensory recovery do not necessarily synchronize. In our series of 63 sutures, 22 per cent reached adequate recovery, both motor and sensory (*Fig.* 499).

Lateral Popliteal.—Here the results are poor, and the percentage of complete failures is high. In the M.R.C. follow-up of 190 patients, 12·7 per cent recovered action in the dorsiflexors against gravity, 87 per cent failed (*Fig.* 500). In our centre the figures with a longer follow-up are slightly more encouraging, as 31 per cent recovered power of dorsiflexors (*Fig.* 501).

It is fortunate that the functional disability is slight. A toe-raising spring will replace the action of the paralysed dorsiflexors of the ankle (*Fig.* 502). The attachment of the spring to the shoe should be on the outer side, as otherwise there is a tendency for the foot to assume the varus position (*Fig.* 503).

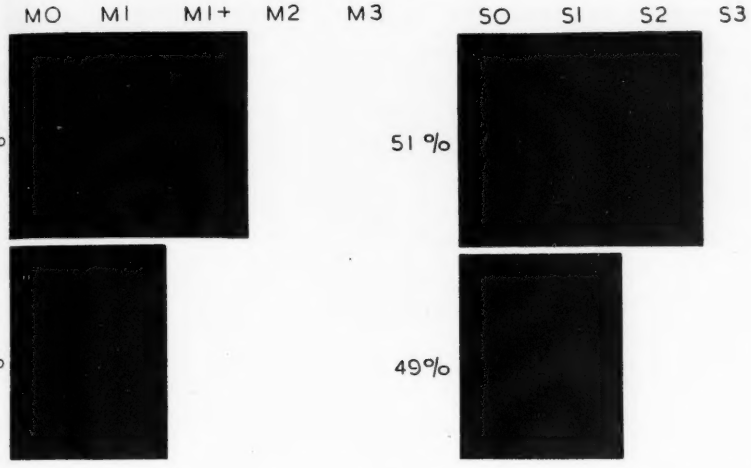


FIG. 497.—Motor recovery in 109 medial popliteals sutured over one year.

FIG. 498.—Sensory recovery—109 medial popliteals sutured over two years.

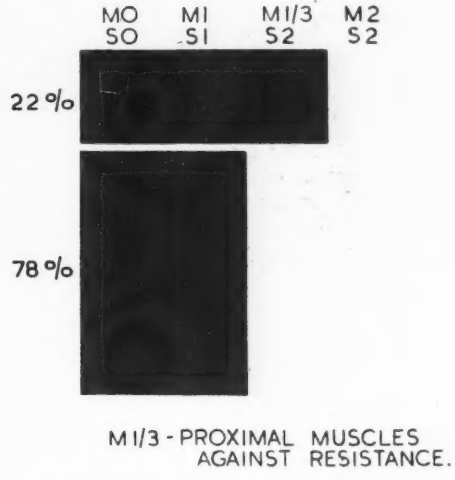


FIG. 499.—Recovery in 63 medial popliteals sutured over one year.

A night splint should be given if there is voluntary power in the calf, as otherwise fixed flexion deformity of the ankle—equinus—will follow, from unopposed action of the calf muscles.

When both elements of the sciatic are divided it is surprising to find that the results of suture are as good as, and indeed in our series of 33 cases are rather better than, with suture of one element alone

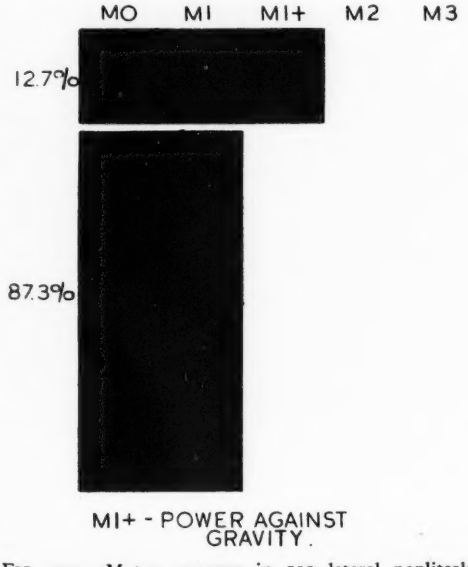


FIG. 500.—Motor recovery in 190 lateral popliteals sutured over one year.

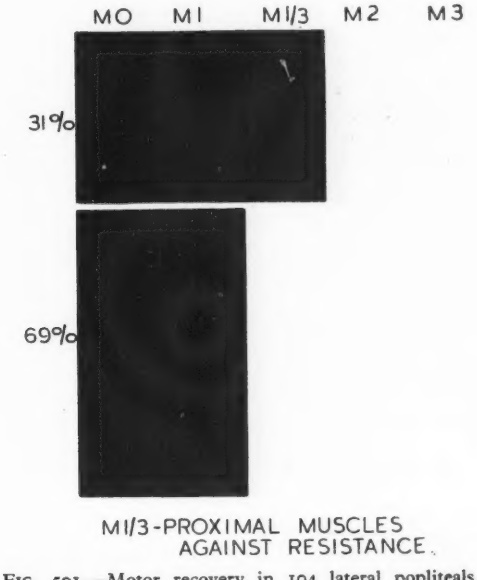


FIG. 501.—Motor recovery in 104 lateral popliteals sutured over one year.

(*Fig.* 504). This means adequate motor recovery in both divisions, with sensory recovery in the medial popliteal element. Professor Seddon tells me the Oxford figures show a similar finding.

Fig. 502

Fig. 503

FIG. 502.—Toe-elevating spring correctly adjusted to the outer side of the foot, with lateral iron.

FIG. 503.—Illustrates tendency of the foot to fall into varus in the absence of the spring on the outer side of the foot.

RESULTS OF BULB SUTURE

If the gap found at operation is too wide to be overcome by the usual technique of free exposure, posturization of the limb, and so forth, bulb suture —the two-stage operation—should be considered.

The numbers are small —we have only 3 or 4 cases, and a similar number have been done at the Oxford Centre, but for what it is worth it may be said that in both centres the results following this two-stage operation are just about up to the average of an ordinary suture. This is somewhat surprising in the light of our experience of traction lesions and nerve stretching generally, but is encouraging. The difficulty arises in that the surgeon may not realize that he is up against a gap too great to permit of suture until he has paired back the bulbs. It is not always possible to be sure how much one will have to sacrifice in either the distal or the proximal stump before the nerve face is good enough for suture. In doubtful cases it would seem wise to do a bulb suture, unless one can be fairly sure that the cut faces can be approximated end to end.

NERVE-GRAFTING—THE PRESENT POSITION

In reviewing the lessons of the 1914–18 war, it was stated that nerve-grafting was condemned, excepting as a last resort, and that the results of this operation were generally failure, and that those claimed as successes seldom stood up to a critical examination.

Heterogenous and homogenous grafts are still to be regarded as failures in our experience in this

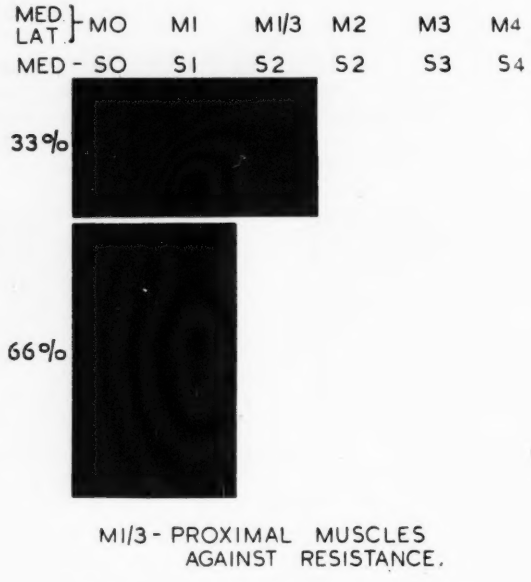


FIG. 504.—Recovery in 33 sciatics sutured over one year.

country. The Russians have used homogenous grafts, according to the scanty literature which has found its way over here, and claim good results. The American surgeons at the Walter Read in Washington in 1944 were carrying out homogenous grafting operations. Our results in this field are all failures and several small series have been reported (Barnes, Bacsich, and Wyburn, 1945).

The position with regard to autogenous grafting is more hopeful, and especially in the case of purely sensory nerves such as the digitals.

Stirling Bunnell and his followers have also obtained satisfactory recovery by autogenous grafting of the digitals.

It is worth while, then, to explore still further the possibilities of the autogenous graft, and this is being done (*Table VII*). For example, a hand with complete cutaneous anæsthesia of the median area is for practical purposes a useless hand. If there is irreparable damage of the median and ulnar, the ulnar may well be sacrificed and a length of ulnar used to bridge the median gap. The cross-section of the graft and the host should be roughly equal. A single strand of the radial taken from the forearm would be useless for bridging a gap in the median in the arm; therefore, two or three lengths—the so-called cable graft—is used. Fibrinogen plasma (glue) is the ideal material in joining these small nerves, as they can be co-apted without tension.

One final word concerning grafts: whilst a difficult suture is a laborious and time-consuming operation, a grafting operation by comparison is simple. The surgeon must make very sure that he is in fact driven to use an autogenous graft, and that in spite of all his persistence and ingenuity

he is compelled to abandon direct end-to-end suture, for all our present experience leads us to expect that the best recoveries follow suture.

Topographical confusion in regeneration will be greater if we are called upon to trim back the nerve-ends for any distance before we find the faces of the

Table VII.—Results of Autogenous Grafting

(Represents the experience of the Oxford Centre up to date, as reported at the XLIX Congrès français de Chirurgie, Paris, October, 1946. This is reproduced by the courtesy of Professor Seddon)

Type of Graft	Nerve	Cure	Partial Cure	Failure	Operation Recent	Total
Cutaneous nerve	Digital	7	2	6	1	16
Cable graft	Brachial plexus	—	1	2	—	3
	Median	4	—	1	1	6
	Various	2	1	1	—	4
Thick grafts	Median	8	—	2	3	13
	Sciatic	—	1	—	4	5
	Various	1	—	3	—	4
Partial Lesions.— Cutaneous nerve	Brachial plexus	1	—	1	—	2
	Median	—	—	—	2	3
	Ulnar	1	—	—	2	3
		24	5	16	13	58

SOME REASONS FOR FAILURE

Apart altogether from gross lesions with a large area of destruction, when end-to-end suture may be impossible, a detailed study of the histology of the suture line will convince us at once that we are expecting the impossible if we look for anything approaching 100 per cent neurological recovery (*Figs.* 505–507).

stumps sufficiently good to suture. The internal anatomy of the nerve-trunks has been worked out in considerable detail, if with varying results, following the pioneer work of Stoffel, of Heidelburg (1912), down to the recent work of Sydney Sunderland in *Brain* (1945), and although the surgeon will do all he can to avoid axial rotation or torsion of either proximal or distal end, it is obvious that co-aptation cannot be accurate. A sensory or motor fibre will grow down an empty Schwann sheath, but if a motor

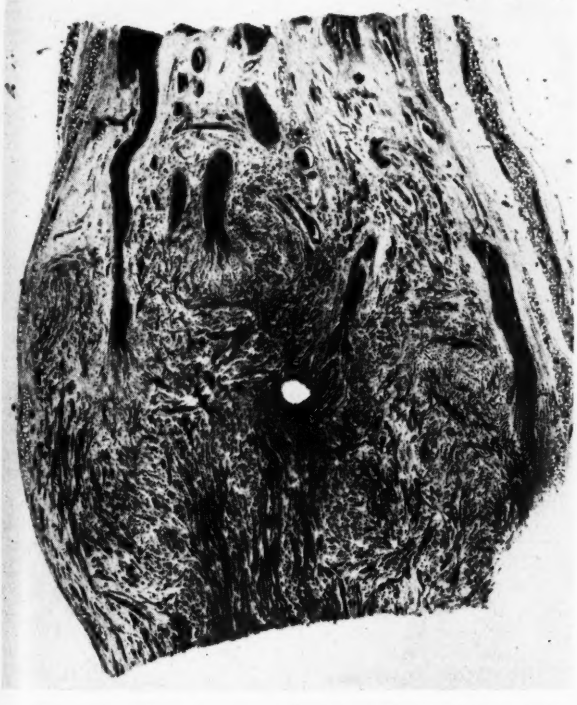


Fig. 505.—Shows a neuroma junction with excellent approximation. It shows the best that can happen at a junction (according to Greenfield), and illustrates the constant ramification and intercrossing of nerve-fibres which run transversely and obliquely rather than longitudinally, passing from the upper to the lower end.

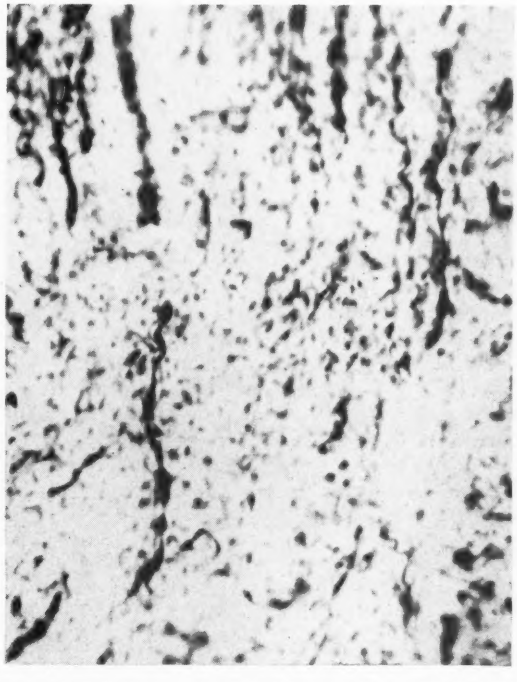


Fig. 506.—Illustrates an unhealthy neuroma, with beading of many of the axons, which are sparse, and dense fibrous tissue in excess. The section is taken from a neuroma of the external popliteal, a lesion in continuity, which was rightly resected and sutured, and which made a good motor recovery two years after suture.

fibre has gone astray, it will make no connexion with a sensory end-organ. Similarly a sensory fibre will make no connexion with a motor end-plate. Hence a mixed nerve like the ulnar should be far more likely to fail to recover neurologically than a pure sensory nerve such as a digital, and this is what we find in practice.

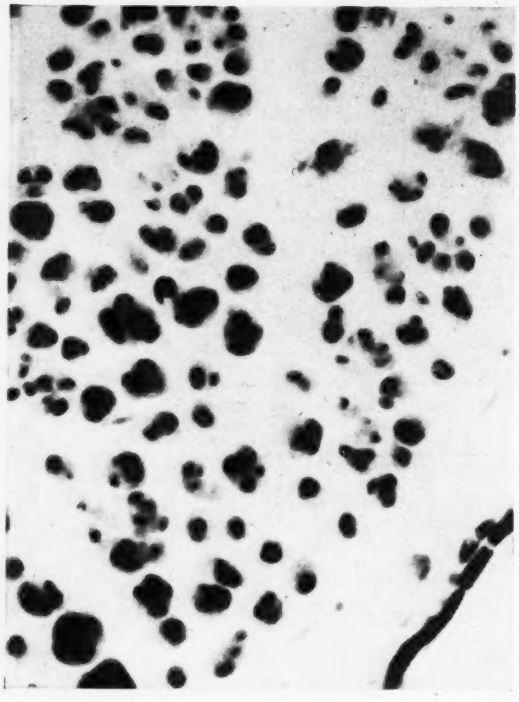


FIG. 507.—The proximal end of a divided median gives a good idea of the multiplication of axons at the point of outgrowth. The illustration shows many groups of nerve-fibres, three and four distinct myelin sheaths within a common sheath. This patient was making a normal recovery when last seen.

Again, at times we are of necessity forced to suture when the freshly cut ends do not look too good, because we realize that further trimming will leave a gap preventing approximation. We have microphotographs of the face of the proximal and distal stump filed with the notes, and it is rather the distal than the proximal face which is of importance. The fact that a proximal end-bulb is formed means that axons are regenerating, that there is activity. The macroscopical appearance of the trimmed distal end at the time of suture may be deceptive. The nerve may feel normal and the sheath may strip easily if there is no general interstitial fibrosis and the collagen is in the nerve-bundles. The fibrosis in the bundles may be central or peripheral. This collagen formation fills the Schwann tubes and forms as far as is known a permanent barrier to the down growth of the axon (*Figs.* 508–510).

These sections from our centre which Professor Greenfield has kindly prepared and reported on illustrate some of the difficulties the axon encounters and in part explains the poorness of neurological recovery.

It is commonly held that the surgery of peripheral nerves assumes importance only in war, and plays a very small part in the surgery of civil practice. With the large number of accidents occurring both in industry and on the road with modern transport conditions, the problem is one which is taking on considerable proportions (*Table VIII*).

In the Birmingham Accident Hospital William Gissane, the Clinical Director, informs me that in one year some 40 digital nerves are repaired, roughly 10 medians or ulnars about the wrist, 1 or 2 about the elbow, and similarly 1 or 2 lateral popliteals divided just below the knee. It is the practice at that hospital to suture the nerves when the wound is dealt with primarily, and the results are reported to be good—for example, a patient recently was returned to a precision job in a factory after suture of six digital nerves in the right hand, following a cut in the distal part of the palm.

Thanks to the work of Stirling Bunnell and his followers, the importance of the digital nerves is now realized, and their repair has a definite place in the reconstructive surgery of the hand.

Training both in the diagnosis and in the treatment of peripheral nerve injuries will need to be stressed, especially for those who intend to practise accident surgery. It is within the experience of many surgeons to have seen unfortunate results following the repair of cuts about the wrist, and to have met with a divided median or ulnar joined to a tendon, the true state of affairs being unrecognized. There is nothing especially difficult in diagnosis, but the pitfalls and abnormalities met with must be appreciated.

Table VIII.—CAUSAL FACTORS
(Jan. 1, 1941, to Dec. 31, 1946)

	G.S.W.	ACCIDENTAL DAMAGE—MOTOR CYCLE, ETC.	FRACTURE OR DISLOCATION	LACERATION	TOTAL
Brachial plexus	51	55	16	1	123
Median	375	10	11	55	451
Ulnar	538	33	34	59	664
Radial	272	20	28	1	321
Dorsal interosseous	77	1	4	3	85
Axillary	10	9	6	—	25
Musculocutaneous	19	—	2	—	21
Internal popliteal	357	10	19	3	389
External popliteal	462	20	30	8	520
Posterior tibial	35	1	1	—	37
Total	2196	159	151	130	2636

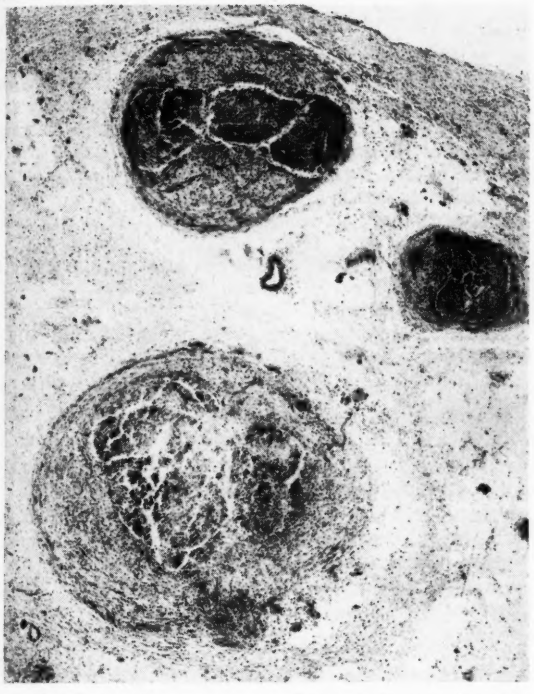


FIG. 508.—Shows crescents of fibrosis in many bundles, and is from the distal face of a sciatic sutured nearly two years ago and which has shown no sign of recovery.

FIG. 509.—From the distal face of an ulnar, showing central and paracentral fibrosis and some normal fibres. Sutured just over three years ago and shows recovery well up to average.

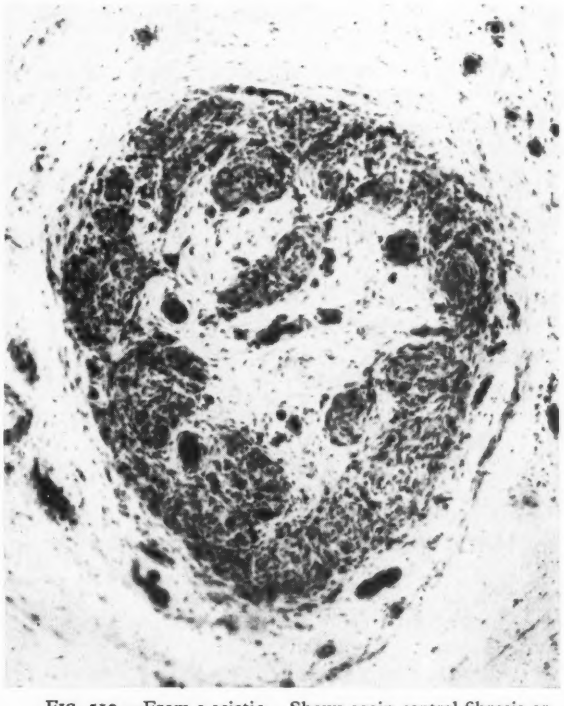


FIG. 510.—From a sciatic. Shows again central fibrosis or collagenization in the bundle. This sciatic was sutured in 1943, two years and three months after wounding, as he was a P.o.W. He made no recovery and the leg was amputated.

As a complication of fractures, peripheral nerve damage is not infrequently seen, but complete division is rare.

There are many points which cannot be discussed in the time at our disposal—the whole question of pain, the pain of over-reaction, which in the majority of patients gradually passes off, although I well remember an officer in the 1914 war in whom recovery reached this stage and remained stationary for fifteen months. His was the pain of over-reaction, and finally, I amputated because he was prevented from walking or even standing with weight on that foot.

Causalgia, the distressing condition described originally by Paget, but generally ascribed to Weir Mitchell, characterized by burning pain, intense, persistent, and subject to exacerbations, is fortunately rare, and in its severe form has only occurred some four times in our series. It must be sharply differentiated from the pain of over-reaction.

The difficult problem of the treatment of the lesion in continuity and the partial lesion, when the surgeon is called upon to exercise his judgement in deciding whether to resect and suture or to leave, must be left for discussion at a later date, and so must the complication of aneurysm and the need for early operation before the nerve is ruined and incorporated as part of the aneurysmal sac.

These and many allied parts of the whole story of injuries to peripheral nerves are a fascinating study and will give interest to our subject for some time to come.

I wish to express my grateful thanks to a number of my colleagues for their valuable co-operation in the work of the Pyrford and Botley's Park Nerve Unit; and in particular to Dr. B. M. Unkauf, who attended to the after-care of the patients, was responsible for the notes, and prepared the illustrations and histograms. I would also like to thank Dr. J. M. Greenfield, who carried out the pathological work in his laboratory at Queens Square, and advised me on the preparation of this section of the paper.

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PENICILLIN THERAPY IN LATE INFECTED COMPOUND FRACTURES FROM BURMA

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MAJOR J. H. BOWIE, I.M.S., I.A.M.C.
AND CAPTAIN M. D. BORCAR, I.M.S., I.A.M.C.

THESE observations are the result of the study of wounds in 75 British troops with late infected compound fractures admitted to the War Wounds Research Centre in Secunderabad, four months on an average after being wounded in Burma.

ON ADMISSION

General Condition.—Before being wounded, some of the patients had been on 'K' or similar rations for as long as three months and in the blood of 55·9 per cent malaria parasites had been demonstrated; for months many had suffered from intermittent attacks of diarrhœa and dysentery.

Many of those admitted during the hot weather were suffering from effects of heat sustained during their long journey by road, sea, and rail.

Seven cases were admitted with all the signs and symptoms of a severe vitamin-B complex deficiency. Lieut.-Colonel J. A. Manifold, R.A.M.C., had observed that many of the wounded evacuated from Burma were suffering from a macrocytic anæmia. Among this series of 75, 48 were anæmic (28 of these were moderate or severe) and 38 were macrocytic in type. There was no achlorhydria and the Van den Bergh test was negative. Since manifest avitaminosis was present in one-tenth of the cases, it may be assumed that the macrocytic anæmia, present in more than half the cases, was due to dietetic deficiencies in the forward areas in Burma.

The Fracture.—All the cases had open wounds over the site of the fracture. Where bony union had not occurred before admission, the patient was often seriously ill.

Table I.—DETAILS OF FRACTURES

FRACTURE	No.	UNITED	UNUNITED	AMPUTATED
Ilium	2	2	—	—
Femur	36	10	23	3
Tibia and fibula	10	5	5	—
Tibia	4	4	—	—
Fibula	3	3	—	—
Ankle	1	—	1	—
Talus and 1st metatarsal bone	1	1	—	—
Calcaneus	2	1	1	—
Scapula	1	1	—	—
Humerus	10	6	4	—
Ulna	1	—	1	—
Radius	1	1	—	—
3rd metacarpal	1	1	—	—
Totals	73	35	35	3

In the 33 fractures of the femur, the fracture site was as follows:—

Upper third	14
Junction of upper and middle thirds	1
Middle third	6
Junction of middle and lower thirds	2
Lower third	10
Total	33

Of the 73 fractures, 3 of the femoral fractures had been amputated in the forward areas, leaving a total of 70. Of these, 68 cases were subsequently evacuated or discharged and only these will be considered in assessing results. In these cases, a total of 128 wounds were treated, 84 by suture and 44 without suture. Of the 84 sutured wounds, 68 communicated with an infected fracture, either united or ununited, and the remaining 16 wounds did not.

The Wound Flora.—Plaster casts often interrupted bacteriological study of the wounds.

In view of the age of the wounds, anaerobic cultures were only set up where the possibility of such infection was suspected after examination of the direct smear or from the clinical aspect, i.e., in cases where the absence of pyogenic cocci in the wound discharges and in cultures of bone incriminated a Gram-negative organism as the pathogen.

Pyogenic staphylococci were identified by the production of hæmolysins for human blood, pigmentation, mannitol fermentation, and the coagulase test.

Organisms of the proteus group were present in more than half the specimens examined. The majority of species encountered tended to swarm over the surface of culture media and render the identification of other microbes difficult. The incorporation of chloral hydrate (Lode and Howard, 1932) in the culture media proved invaluable in inhibiting this tendency. In a final concentration of 1–500, the drug did not inhibit the growth of any other organism found in the wounds.

Table II.—The Incidence, on Admission, of Various Organisms in the Wounds of 65 Cases

Micro-organism	Number of Cases in which the Organism Appeared	Percentage
Str. pyogenes	18	27·7
Staph. aureus	25	38·5
Ps. pyocyanea	13	20·0
Proteus group	35	53·8
Coli-aerogenes group	7	10·7
Diphtheroid group	23	35·4
Str. viridans group	6	9·2
Staph. albus	5	7·7
Other organisms (non-pathogenic)	3	4·6

Table II was compiled from the results of examinations performed for each patient on two consecutive days at the time of admission or, where the wound was hidden by a plaster cast, when the wound was first exposed in the Centre.

On an average six subsequent examinations were carried out in this group of fracture wounds, at intervals of ten days. Of the 65 cases, 43 (66·1 per cent) acquired superadded infection while in hospital in spite of all feasible aseptic precautions.

Before dressings were commenced in the ward a quiet hour was observed during which no unauthorized person was allowed into the ward, bed-making and floor-sweeping were forbidden, and the electric fans were switched off. During ' dressing hours ' all patients and staff were masked and the ' no touch " technique was used by specially trained sisters in charge of dressings. All movement in the ward was reduced to a minimum, and special emphasis was laid on gentle manipulation of bedclothes.

A comparison between the incidence of the various organisms as they appeared in wounds on admission and as they appeared in hospital infections, reveals that, with exceptions, the two were directly proportional. This relationship indicates that the source of hospital infections was other wounds in the Centre. The exceptions suggest that these infections were generally airborne; this is hardly avoidable in a Base hospital during the hot weather when fans are a necessity.

OBSERVATIONS ON PRELIMINARY INVESTIGATIONS AT THE BASE

Result of Penicillin Therapy in Forward Areas on Wound Flora.—Wounds may be classified as Gram-positive or Gram-negative according to the presence or absence of pyogenic cocci in the discharge.

Considering, month by month for a year, the admission of patients to whom penicillin had *not* been administered in Forward Areas, the number of Gram-positive wounds was never less than the number of Gram-negative wounds. The relationship for the year was 1·1 : 1·0.

Among those to whom penicillin *had* been administered, the number of Gram-positive wounds fell progressively quarter by quarter—demonstrating a progressive improvement in Forward operative technique and associated penicillin administration. During the last three months of the Burma Campaign the proportion of Gram-positive to Gram-negative wounds had fallen from 1·1 : 1 to 1 : 9.

Inadequate penicillin administration in Forward Areas, whilst reducing the rate of *Str. pyogenes* infections by one-third at the time of admission to the Centre, also raised the rate of resistant pyogenic staphylococci from 0 to 30 per cent.

Penicillin-resistant Pyogenic Staphylococci.—Having isolated and identified the staphylococcus in pure culture, a rough indication of its sensitivity was obtained by plate tests; thereafter a more exact sensitivity value was determined by culture in appropriate serial dilutions of penicillin (equivalent of P.B.S.) in broth. A control series inoculated with a standard test organism (N.C.T.C.6571A) was always set up.

Penicillin-resistant pyogenic staphylococci may occur in wounds as a natural phenomenon; 16 strains were examined from the wounds of patients who had never had penicillin and all proved sensitive to 0·04 units per ml. The resistance of normally sensitive strains may be enhanced by inadequate penicillin therapy; 14 were examined and 4 (29 per cent) were resistant to 0·04 units per ml. Resistant strains may gain access to wounds as cross-infections; 13 strains in hospital infections were examined and 4 proved resistant (31 per cent).

If *Staph. aureus* is present, its sensitivity should be determined before starting treatment and the dosage of penicillin calculated accordingly. Strains whose resistance are up to 16–32 times greater than the Oxford staphylococcus were satisfactorily controlled by increasing the dosage accordingly. Very resistant strains are outside effective control and contra-indicate the use of penicillin, unless or until

the resistance falls to within reasonable limits. In treating strains whose resistance is within reach of penicillin therapy, it is most important that an adequate dosage be administered from the start, lest their resistance be increased beyond the level of penicillin which can be maintained continuously in the body.

In several cases it was noted that a rapid and striking increase in the resistance occurred as the result of inadequate penicillin therapy. In one case the resistance of the infecting organism on admission was between 16 and 32 times as great as that of the test organism. Six days later it had become 780 to 1560 times more resistant. During this period the patient was receiving 20,000 units of penicillin every three hours—a grossly inadequate dose in this case.

It was our experience that intramuscular injections of 20,000 units of penicillin every three hours, combined with suitable surgery, controlled infections due to strains of *Staph. aureus* the sensitivity of which is equal to that of the standard Oxford staphylococcus, but that they will not control infection due to more resistant organisms.

A united compound fracture of the upper end of the humerus, with a sinus leading to bone, proved to be infected with *Staph. aureus* twice as resistant as the test organism. Penicillin therapy, 30,000 units every three hours, was started; 48 hours later the sinus was excised, radical removal of bone performed, and the wound totally sutured under no tension and without drainage. After operation pyrexia occurred, a superficial sinus appeared in the wound, from which the staphylococcus was recovered, and the wound showed signs of inflammation. The staphylococcus was now between 2 and 4 times as resistant as the test organism. The dosage was increased to 40,000 units. The temperature immediately fell to normal, inflammation subsided, and the sinus closed within four days.

A second patient had an infected compound fracture of the upper end of the femur. His general condition was poor and deteriorating rapidly; he had been receiving 20,000 units of penicillin every three hours for 28 days. When we saw the patient he was gravely ill with high swinging temperature and rapid pulse. A *Staph. aureus* 16 to 32 times more resistant than the test organism was recovered from the wound. The dosage of penicillin was increased to 200,000 units every two hours and maintained at that level for 19 days. There was an immediate response on the temperature and pulse charts and a striking improvement in the general condition. Four days later the grossly diseased head of the femur was removed and the infected hip-joint drained; the general condition caused no anxiety either during or after the operation. Subsequent progress was satisfactory. Massive penicillin therapy probably saved his life. He received the enormous dose of 23·2 mega units.

The dosage of penicillin necessary to control infection due to *Staph. aureus* depends upon the sensitivity of the organism. In a case of purely Gram-positive infection where the clinical response to penicillin is disappointing, inadequate therapy should be assumed, and the sensitivity determined as rapidly as possible.

The exact relationship between resistance and dosage necessary is at present unknown. In treating infections due to resistant strains of *Staph. aureus*, continuous administration of penicillin would provide the most accurate method of giving the exact dose required. Were a really satisfactory method of continuous administration available, this would be the ideal method of treating cases of this type. It is hoped that the electric apparatus for continuous injection devised at Secunderabad will provide one possible answer to this problem. This apparatus will form the subject of a separate report.

Pathogenicity of Gram-negative Organisms.—With power to control Gram-positive pyogenic cocci by the exhibition of penicillin, we were impressed by the virulence of some Gram-negative infections in bone and by their ubiquity in wounds in the East.

It has been shown that proteus was present in over half the wounds, *Ps. pyocyanea* in a fifth, and *Bact. coli* in a tenth. These Gram-negative organisms were the cause of nearly all the failures of wound closure; they were much the most common cause of chronic low-grade infection in bone, leading to persistent sinuses, and they were the major cause of virulent spreading infection threatening life or limb. This is well illustrated by the fact that in the 4 cases of this series for which amputation was necessary in the Centre for fulminating infection the causal organisms in 3 were proteus and *Ps. pyocyanea*; no pyogenic cocci or anaerobes were found on repeated examination. In the fourth case a mixed infection was present with *Staph aureus* and *Str. hæmolyticus* on the one hand, and proteus, *Ps. pyocyanea*, and *Bact. coli* on the other. No amputation was performed in the absence of Gram-negative organisms. The combination of general treatment, penicillin therapy, and surgery did not influence the course of the disease in any of these four cases.

Now that *Str. pyogenes* and most strains of *Staph. aureus* can be controlled by penicillin, Gram-negative infection must be regarded as a major hazard in this theatre so far as compound fractures are concerned.

Fallacies in Radiological Interpretation.—In this series of late infected compound fractures three difficulties were encountered in the interpretation of radiographs:—

1. *Infection.*—The heavily comminuted fractures resulting from war injuries lead to gross disruption of bony architecture in the region of the fracture. When to the direct effects of the injury are added the radiological changes produced by reparative processes, a complicated picture results. Infection occurring on such a background does not give rise to the radiological features usually associated with osteomyelitis.

Less and less reliance was placed on X rays in endeavouring to assess the extent of infection present in common comminuted fractures before union had occurred. Extensive spreading intramedullary infection was found at operation on several occasions when the radiographs gave no evidence of its presence. In one such case of compound fracture of the femur infection was demonstrated in the marrow cavity for 8 in. above the site of fracture. When

union had occurred the radiographs provided reliable evidence of the extent of infection.

2. *Sequestration.*—In the more severely comminuted fractures it is sometimes impossible to differentiate portions of living cortex from sequestra. These portions of cortex may remain denser than the surrounding bone. They can be recognized as cortical fragments by virtue of their shape, but they cannot be positively identified as sequestra solely on their density. Several operations were performed for the removal of such fragments which had been regarded as sequestra on radiological evidence, but were found to be living fragments of cortex firmly attached to soft tissues from which they received an adequate blood-supply.

3. *Bony Union.*—In extensively comminuted compound fractures, clinical union may be firm, although radiographs provide no evidence of union. We were surprised on more than one occasion to find that a fracture was clinically firm when examined in the operating theatre although the X-ray picture had led one to suppose that it would be freely movable.

TREATMENT AT THE BASE

Treatment was carried out along four main lines—general, chemotherapeutic, surgical, and orthopædic.

General Treatment.—This consisted mainly in dietetic replacement therapy.

For effects of heat on admission the patients required sedatives, rest in cool, dim, quiet wards, and 3–4 litres of cold fluids a day.

Diets particularly rich in proteins were devised to include liver, vitamins, and iron. Repeated blood transfusions, sometimes over a period of many weeks, were necessary in the more seriously ill patients. Fresh blood was used in preference to stored blood. It was remarkable how rapidly the red-cell count and hæmoglobin fell to the pre-transfusion level in the presence of severe toxæmia. In this type of case, treatment was controlled by serial hæmograms as long as severe toxæmia persisted.

On admission, the plasma proteins were frequently low; plasma, whole blood, and hydrolysate were not spared in these cases.

On the grounds that every degree Fahrenheit rise in body temperature entails a 10 per cent increase in the basal metabolic rate, the toxic cases were pressed to consume high-calorie diets.

Chemotherapeutic Treatment.—The main object of this investigation was to determine the efficacy of penicillin administration in the treatment of late, infected compound fracture cases from Burma at bases in India.

Penicillin was administered to every case, irrespective of the bacteriological findings and no other chemotherapeutic agent was employed.

For the first two months 15,000 units were injected every three hours; subsequently this was increased to 20,000 units. Eventually the dose was correlated as far as possible with the resistance of the particular staphylococcus.

With regard to pain, we found nothing to choose between sterile glass-distilled water and sterile buffered saline of *p*H 6·8 which we use as the routine vehicle. A reduction in the volume of the injection from 3 to 2 ml., however, definitely reduced the discomfort produced by the injection. In the same way, using continuous penicillin therapy, we found that reduction in discomfort was proportionate to reduction in volume through the range 100 ml. (Eudrip), 20 ml., 10 ml., and 2 ml. (Secunderabad apparatus) in 24 hours.

Our routine was to begin penicillin therapy 48 hours before operation, with the object of (*a*) rendering the blood and tissues at the site of operation bactericidal, and (*b*) eliminating infection in blood-bearing tissues. The injections were continued after the operation for a period which depended on the clinical response.

Local instillation via narrow-bore rubber tubes was employed in 16 cases. In 8 of these there was strong evidence that penicillin-insensitive secondary infection gained entry via the tubes; this method was therefore abandoned as a routine. Thereafter penicillin tubes were only inserted where a dead space was unavoidably left at the end of the operation.

Surgical Treatment.—Where there was absence of union of the fracture on admission the general condition of the patient was always more grave and the treatment more difficult. A success rate of 57 per cent for united fractures, as against 45 per cent for ununited fractures, reflects the difficulties encountered.

Operative procedures aimed at excision of the wound, radical removal of all bone which was dead or had a diminished blood-supply, obliteration of dead space (if necessary, by saucerization or turning in a muscle flap), and total suture of the wound without drainage.

This procedure was not always possible. Radical removal of bone aimed at leaving behind only bone which looked healthy and which bled, irrespective of whether microscopical infection was or was not present. This was usually possible when the fracture was united, often impossible when it was ununited (*a*) because an irreparable gap might result and (*b*) because it is difficult to assess the blood-supply of comminuted fragments. In many such cases conservative removal of bone, i.e., sequestrectomy, had to be performed.

Obliteration of dead space in bone proved most difficult in the upper quarter of the tibia, a situation where muscle and skin are apt to be deficient. On three occasions a large cavity in the upper end of the tibia was filled with ilial chips and the overlying skin then sutured; on each occasion the wound broke down and the ilial chips were extruded as the result of Gram-negative infection. In all 3 cases the cavity was large and the skin was stitched under considerable tension. In a case of non-union of the ulna in which there was a ¾-in. gap and a sinus down to the site of fracture from which *Staph. aureus* was cultured, primary union followed excision of the wound and the insertion of ilial chip grafts under the protection of a penicillin 'umbrella'. The grafts persisted and fused into a single mass which united with the lower fragment.

Total suture was sometimes impossible owing to loss of skin.

In 3 such cases Lieut.-Col. Peet, R.A.M.C., closed the gap by sliding across a flap of skin and applying Thiersch grafts to the donor area.

This procedure was only found necessary in fractures of the upper third of the tibia and in all three it was eminently satisfactory. Plastic closure should always be preferred to the slow and painful process of healing by secondary intention.

In all cases where dead space could not be obliterated, drainage was provided by partial suture of the wound or by counter drainage.

More and more care was taken in the technique of skin closure; careful suturing repays the time and trouble taken. Tension was found to be an important cause of wound breakdown.

The results of radical as compared with conservative excision of bone were interesting. For united fractures the radical operation gave the better results, 50 per cent of successes as against 38·5 per cent for the conservative operation. In the case of ununited fractures the success rate was identical for both operations—namely, 40 per cent. The probable explanation for this discrepancy is that radical removal of diseased bone was technically possible in the case of united fractures, but not in those that were ununited. It is probably not worth attempting to perform the radical operation before union has occurred.

It was not possible to draw any conclusions as to the relative merits of total suture without drainage, total suture with counter-drainage, and partial suture because the numbers in the latter two groups were too small.

Results.—Of all the factors influencing the success of operative procedures designed to close the wound under cover of penicillin therapy, the most important was the bacteriology of the wound.

In this series of late infected compound fractures, it was found that (*a*) when only pyogenic cocci or 'miscellaneous' organisms were present the results were uniformly good, whether the fracture was united or not, and (*b*) when Gram-negative, penicillin-insensitive bacteria were present the results were poor.

All factors other than the bacteriology were constant; every case had penicillin therapy and all the operations were performed by the same surgeons, using a standardized technique. The results obtained are illustrated in *Table III*, which represents the position with regard to the bacteriological group at the time of operation. By success both here and hereafter is meant primary union of the wound or complete healing of the wound except for small areas of epithelial defect on the suture line or at the sites of sutures. All other results are classified as failures.

Table III indicates that in 15 cases in which there were no Gram-negative organisms (the sterile, Gram-positive, and miscellaneous groups) there was only 1 failure. The wound in this case broke down partially leaving a persistent sinus to bone and was examined thereafter on four occasions from the 6th to the 126th day after operation. Proteus was present on all four occasions, on the first alone and on the last three in association with diphtheroids. *Staph. aureus* and *Str. pyogenes* were not present on any of these four occasions, and anaerobic cultures were negative. This strongly suggests that the cause of failure was due to the presence of Proteus which probably gained entrance to the wound at or just before the time of operation, since it was present at the first inspection of the wound after operation. There is thus no case in this series in which *Staph. aureus* or *Str. pyogenes* can be incriminated as the cause of failure.

On the other hand, in 62 cases in which Gram-negative organisms were present (the Gram-negative and mixed groups) there were 34 failures. These two sets of figures represent success rates of 93 per cent (? 100 per cent) and 45·2 per cent respectively.

Miscellaneous organisms, especially diphtheroids, were present in many of the Gram-positive, Gram-negative, and mixed groups of wounds. Thus diphtheroids were present in 35·4 per cent of 65 wounds examined on admission. These organisms gave no evidence of pathogenicity.

Table III.—RESULTS OF TREATMENT

WOUND GROUP*	NUMBER OF CASES		
	SUCCESS	FAILURE	TOTAL
Sterile	2	—	2
Gram-positive	11	1	12
Gram-negative	13	16	29
Mixed	15	18	33
Miscellaneous	1	—	1
Totals	42	35	77

* *Gram-positive Wounds*: *Staph. aureus* and *Str. pyogenes*, either alone or together, or in association with any organism other than *Ps. pyocyanea*, proteus, or *coli-aerogenes* group.
Gram-negative Wounds: Proteus and *coli-aerogenes* groups and *Ps. pyocyanea*, either alone, together, or in association with any organism other than *Str. pyogenes* or *Staph. aureus*.
Mixed Wounds: Any combination of organisms provided that at least two of the five important organisms are present—one from each of the Gram-positive and Gram-negative groups.
Miscellaneous Wounds: Any association of organisms other than the five important organisms mentioned above.

Two inferences were drawn from these results:—

1. Penicillin therapy will control infection, even in late compound fractures, due to *Staph. aureus* or *Str. pyogenes*, provided it is combined with adequate surgery.

2. Proteus, *Ps. pyocyanea*, and *B. coli* may be pathogenic when established in bone and were the main cause of wound breakdown and chronic suppuration in this series.

DISCUSSION

Indications for Penicillin Therapy in Late Infected Compound Fractures.—The investigation gave clear evidence that the sole criterion for giving, or withholding, penicillin was the result of bacteriological examination of the wound. It was established that where penicillin-sensitive pyogenic cocci alone were present, the results were excellent and the wound could be closed with confidence. When Gram-negative organisms were present, however, the results were poor; the wound broke down in over half the cases, and spreading infection, if present, was not controlled however good the surgery.

It may therefore be stated that when Gram-positive infection is present penicillin should be given, when Gram-negative infection is present penicillin should be withheld, and when miscellaneous infection is present penicillin therapy is unnecessary. When a mixed infection is present

penicillin should be administered to eliminate the Gram-positive element. The Gram-negative element will, however, remain, and good results must not be anticipated. *Table III* indicates that the results of wound closure associated with penicillin therapy were equally poor in the mixed and Gram-negative groups of cases.

Bacteriological examination of bone removed at operation in 34 cases revealed that in 32 (94 per cent) all the organisms isolated from bone had already been identified by examination of the wound discharges. This suggests that pus is a reasonably efficient guide as to the probable outcome of penicillin therapy in any particular case of late compound fracture. In the two remaining cases, *Staph. aureus* was isolated from bone, but not from pus till after the operation. A sinus to bare bone was present in both cases. This suggests that a piece of diseased bone, removed at operation, should be examined as a check on the culture of pus.

Secondary Hæmorrhage.—Secondary hæmorrhage occurred in only 2 cases, including one of the three amputated for pure Gram-negative infection. This patient had three secondary hæmorrhages after his amputation, the first of which was almost fatal. The second patient had a small secondary hæmorrhage from a branch of the superior gluteal artery. This followed a three-stage hindquarter amputation for spreading osteomyelitis of the pelvis originating in a compound fracture of the upper end of the femur. The infection in this case was mixed.

Gas Gangrene.—No case of gas gangrene occurred.

Mortality.—One patient in this series died, but his death was unrelated to his injuries. Just before he was due for discharge, he developed a fulminating type of infective hepatitis from which he died within a week. There was no death from sepsis in spite of the fact that only the most severe compound fractures were segregated in the War Wounds Research Centre.

SUMMARY

1. Late compound fracture cases from Burma in addition to the conditions produced by their injuries, suffered from effects of heat, dietary deficiencies, macrocytic anæmia, malaria, diarrhœa, and dysentery.

2. In spite of all feasible aseptic precautions, hospital infection occurred in 66 per cent of the wounds; these infections included a high rate of penicillin-resistant strains of *Staph. aureus*. It was inferred that the source of infection was other wounds in the Centre, that the infection was airborne, and that electric fans were partially responsible.

3. It was observed that inadequate penicillin administration in Forward Areas reduced the number of Gram-positive wounds admitted at the Base, but produced a rise in penicillin resistance of the pyogenic staphylococci persisting in wounds.

4. Improvement in Forward penicillin administration was proved to be progressive; towards the end of the Burma Campaign it had become highly successful in the eradication of Gram-positive infection in compound fractures.

5. It is suggested that: (*a*) The dose of penicillin should be more closely correlated with the resistance of the infecting organism, which should be determined by dilution tests; (*b*) That local penicillin should only be used where dead space is surgically unavoidable.

6. Operative procedures aimed at excision of the wound, removal of all bone without an adequate blood-supply, and closure of the wound without drainage. The usual technique used for the obliteration of dead space not amenable to saucerization was the turning in of a pedicled flap of muscle.

7. The results of treatment indicated that: (*a*) Gram-positive infection in bone can be controlled by adequate penicillin administration associated with efficient operative procedures, even at a late stage in compound fractures; (*b*) Where penicillin is used effectively in compound fractures and eradicates Gram-positive infection, Gram-negative organisms are the main cause of (i) low-grade infection in bone leading to persistent sinuses, (ii) virulent spreading infection threatening life and limb.

We have pleasure in acknowledging the direction of Brigadier F. Harris, who created, encouraged, and equipped our team. We would like to thank Brigadier Grant Massie, who set and supervised our surgical problems.

We wish to express our gratitude to Colonel D. C. McEttles and his staff at 128 I.B.G.H. (B.T.), Secunderabad, for the innumerable advantages we gained through their co-operation.

PARTIAL GASTRECTOMY FOR SIMPLE ULCER*

A REVIEW OF THE END-RESULTS OF 132 CASES, WITH A CRITICISM OF THE POLYA OPERATION

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"*. . . I ain't gonna let my stomach dictate to me.*"

Impressed by the frequency with which partial gastrectomy is being prescribed for simple peptic ulcer, a follow-up clinic was instituted at the Leicester Royal Infirmary to determine whether the results justified the operation; at the same time some undesirable side-effects of the Polya operation were seen, which led to criticisms of this type of anastomosis.

* Thesis presented for the degree of Ch.M. of the University of Birmingham.

Gastro-enterostomy is now almost entirely reserved for the long-standing organic pyloric stenosis, although there are a few isolated but very staunch supporters of this operation, notably Walton in this country, who advocate the use of this operation almost as the routine for duodenal ulceration. The majority of writers, however, are strongly in favour of gastric resection as the operation of choice, certainly for gastric ulcer, and almost always for duodenal ulcer.

The indications for operation in peptic ulceration have been gone into many times before, and it will suffice to say that most of the cases in this series were advised operation for three main reasons: (1) Lack of response to medical therapy—undoubtedly the war has increased this category of patient; (2) Repeated perforation or hæmatemesis; (3) A suspicion of malignancy—a large number of the older-age gastric-ulcer group lost parts of their stomach on this account.

For the purpose of this review, 129 patients were interviewed personally and 3 replied by letter. All operations were carried out prior to June, 1945, and at the time of interview no patient had been operated upon less than six months previously; patients seen after this date are not included in the figures, although the impressions from seeing them have been utilized.

The results of the follow-up are discussed under several headings, which consider points in regard both to technique and to the effect of partial gastrectomy on the patient, and some attempt has been made to decide which of the very many modifications of the operation give the best long-tern results. The literature on partial gastrectomy is almost unanimous in saying that, at any rate so far, it is the best operation yet devised for the appropriate case, and one feels that it is time that attempts were made to correlate the types of operation, e.g., the width of the stoma, with more 'intimate' end-results, and so in this review I have discussed the results under three main and fairly separate headings, as follows: (1) Clinical and functional result, especially in connexion with the length of the loop and the width of the stoma; (2) The fractional test-meal, with particular reference to the operation of pyloric exclusion; (3) Anæmia.

Mortality.—It has not been possible to work out the mortality for the whole series exactly, but it approximates to 9 per cent. The operation had not been extensively used at this hospital until within the last few years, and this has probably contributed to the high figure. The mortality-rate for one surgeon's personal series is now much less than 4 per cent, a figure which renders the operation one which can be safely advised to most patients.

Type of Operation.—All the cases reviewed here are partial gastrectomies based on the modification of the Billroth II by Mikulicz and Kronlein and by Hofmeister and Reichel, and described in 1911 by Polya, by whose name it is now generally known. Many names have been applied to modifications of Polya's original method, but in this review the following terms will be used in describing the type of anastomosis:—

Isoperistaltic—afferent loop to greater curvature.
Antiperistaltic—afferent loop to lesser curvature.
Antecolic—long jejunal loop, passing anteriorly to colon.
Retrocolic—short jejunal loop, posterior to transverse colon, passing through mesocolon.

In this series the whole width of the stomach was anastomosed to jejunum in all but 2 cases; in these a Hofmeister type of valve was formed; one is an excellent, the other a good, result. Only 2 known antiperistaltic anastomoses were made, both with excellent results; 13 are of unknown type. In all, approximately two-thirds of the stomach was removed.

CLINICAL IMPRESSION

The general impression gained from talking to these ex-patients is that the operation of partial gastrectomy is definitely worth while, and this, as shown later, is confirmed by the figures. Most of these patients express spontaneously their gratitude for the operation.

The average period of convalescence after operation has been three to four months; one man returned after one month and one, who was delayed by a subphrenic abscess, after eighteen months. Most of the workers have returned to their original employment and have not lost time from it since (excepting those in groups 3, 4, and 5 described later). A few have apparently been unable to work as hard as they did previously, but there has been no obvious cause for this; certainly there is no connexion between this inability and anæmia—a great majority of the anæmic patients were working full time.

A number of these patients have failed to increase their weight to their pre-sickness level. Most of them were sparse in build, some were actually worried about their failure to gain weight, and I did not see any patient who could be regarded as obese. Unfortunately these are only impressions, since no figures are available. This impression contrasts with Gordon-Taylor and Hudson (1928), who mention an average gain in weight of 2 st., but agrees with Ingelfinger (1944), who says that many patients find it difficult to gain weight; he quotes Santy and Mallet-Guy, who say that after three years only a few patients experienced difficulty in putting on weight. In about two-thirds of the cases in this review the operation had been performed less than three years previously. Despite their inability to put on much weight, no increased liability to ill health was noticed; on the whole, they appeared to have been extraordinarily well since operation.

Appetite and Food.—Only 2 patients had abnormal appetites, one being more, and one less, hungry than normal. Patients had been advised to maintain an 'ulcer type' of diet for about six months after operation—most of them attempted to do so for a time, but, when seen, the greater majority were eating ordinary food.

On talking to patients about food, several interesting points emerge—their pre-operative experience with food and pain influences the post-operative life of quite a number of patients; hence one has notes of three patients who have been attempting to maintain the diet for over six years since operation—they had never been told to go on to normal food. Another patient who had had an ulcer for ten years said that he was "scared" to go off his diet.

It behoves the doctor to inform the patient that there will be no necessity to maintain a diet once the gastro-intestinal tract has settled down; in fact, from the point of view of anæmia and the functional end-result (*see* later) a good normal diet is to be strongly advised.

A large number of patients do not eat pickles or spices—most had been warned not to do so by their doctor, and none expressed a desire for them. A few (14 in number) mentioned specific articles of food which they found disagreed with them. In some cases they caused fullness, but in others nausea and vomiting of bile was brought on; sweet foods, as suggested by some writers as being the main stimulators of a flow of bile, were not especially incriminated by this group of patients. Many patients did say that fatty foods were " bad for their stomach ", in most cases they caused nausea, and occasionally slight vomits of bitter fluid. This is perhaps associated with the well-known stimulating action of fats on the gall-bladder, with a consequent flooding of the stomach with bile, and is of interest in view of remarks by Ingelfinger, who quotes many references to suggest that some of the intestinal upsets after gastrectomy are secondary to abnormal pressure gradients between the stomach and the small bowel. Ingelfinger quotes from Ravdin, Royster, Reigel, and Rhoads (1943) as follows: " The feeding mixture should not contain too much fat; for even though the mixture is placed in the jejunum, gastric emptying is delayed. Failure to recognize this fact has greatly increased the time of convalescence of many patients."

FUNCTIONAL RESULTS

The functional result, i.e., the present subjective state of the gastro-intestinal tract, has been subdivided as follows:—

1. Excellent: There are no complaints of any sort. All these patients are at full work.

2. Good: Patients with a mild upset in the way of flatulence or fullness after meals, which does not inconvenience them. Let it be said now that most of these patients only mentioned their symptoms on direct questioning—all are extremely pleased about the operation, and all are at full work.

3. Improved: Those who do complain of a definite ' upset ' in the way of flatulence, fullness, or vomiting. All of this group say they have benefited from the operation. Some have lost time from work on account of their upset.

4. Not improved: Those with a severe gastric or intestinal upset, and who say they have not benefited from their operation.

5. Recurrent ulceration.

The results are grouped in *Table I.*

Several points emerge immediately:—

1. 95 per cent of the patients received benefit from the operation.

2. All 3 recurrences were originally duodenal ulcers.

3. Apart from recurrent ulceration, duodenal and gastric stomach remnants seem to behave equally well.

4. Time would appear not to have a very great effect in settling the intestinal upsets, despite its well-known soothing value during the early post-operative months, during which fairly severe upsets are not uncommon.

5. Perhaps of some significance, the ' not improved ' exceed the recurrences in number.

RECURRENCES

There were 3 patients clinically suspect of recurrence, although in none was the ulcer actually demonstrated.

Case.—C. M., male, aged 42, seen 4 years after a three-quarter resection for an anterior-wall duodenal ulcer. An isoperistaltic anastomosis. He complained of a mixture of symptoms, some of which were definitely due to anæmia, but he said that he was quite free from pain for 18 months after the operation. His symptoms were typically ulcer-like in their character and relation to food and alkalis. He was eating normal food with additional 2-hourly feeds.

F.T.M.: No free acid. Low total acid. Emptying time ¾ hour.

Blood-count: 83 per cent Hb. 4,600,000 R.B.C.

X-ray examination: No evidence of ulcer, except slight tenderness. No gastric delay. (Dr. Lawson.)

Case.—H. W., male, aged 50, seen 1 year 8 months after an isoperistaltic antecolic resection for a duodenal ulcer. This man was well for six months after operation and then developed an atypical pain, rather like, but less severe than, his original ulcer pain. He is still maintaining a definite gastric diet.

F.T.M.: No free acid. Low total acid. Emptying time ¼ hour.

Blood-count: Normal.

Table I.—RESULTS

a. General.

		per cent
Excellent	53 (2 by letter)	40
Good	57 (1 by letter)	43·2
Improved	15	11·4
Not improved	4	3
Recurrences	3	2·3
Number of cases	132	

b. According to Site.

Original Lesion	*No. of Cases*	*Excellent*	*Good*	*Improved*	*Not Improved*	*Recurrences*
Duodenal	68	28 (41·2 per cent)	28 (41·2 per cent)	7 (10·3 per cent)	2 (2·9 per cent)	3 (4·4 per cent)
Gastric	59	22 (37·3 per cent)	27 (45·8 per cent)	8 (13·5 per cent)	2 (3·4 per cent)	0
Stomal	5	3	2			

c. According to Length of Time since Operation.

	No. of Cases	*Excellent*	*Good*	*Improved*	*Not Improved*	*Recurrences*
Over 3 years	42	14 (33·3 per cent)	17 (40·5 per cent)	7 (16·7 per cent)	2 (4·7 per cent)	2 (4·7 per cent)
Under 3 years	90	39 (43·3 per cent)	40 (44·4 per cent)	8 (8·9 per cent)	2 (2·2 per cent)	1 (1·1 per cent)

X-ray examination: Normal partial gastrectomy. (Dr. Lawson.)

Gastroscopy: Not successful.

In this case the symptoms were to some extent obscured by jejunal 'dumping' pain.

Case.—C. P., male, aged 50, seen 3 years after a high isoperistaltic antecolic resection for an indurated ulcer, with pyloric exclusion and excision of antral mucosa, the ulcer not being removed.

F.T.M.: 20 c.c. of free acid. Total acid 35 c.c. Emptying time 2¾ hours.

Blood-count: Normal.

X-ray examination: No evidence of ulcer in stomach or stoma. Small amount of jejunitis in the afferent loop, no overloading or obstruction. (Dr. Lawson.)

Gastroscopy: Patient did not attend.

With regard to the temperament of the three patients—C. M. had many business worries, otherwise he seemed to be of fairly normal behaviour; H. W. was definitely introspective; C. P. was of normal behaviour.

The following features are common to these three cases:—

1. They were all males.
2. The original lesion was a duodenal ulcer.
3. The anastomosis was full width and antecolic.
4. There was no X-ray or clinical evidence of afferent loop obstruction.

These three cases support the common beliefs that duodenal ulcers are more likely to lead to recurrent ulceration, and that free acid is only a predisposing factor to ulceration.

The Long-loop Anastomosis.—All were of the long-loop antecolic type, and this is of interest in view of experimental evidence by Wangensteen (1945) and Lannin (1945), who show that in dogs recurrent ulceration is much more frequent in the long-loop type of anastomosis. They use a short-loop (retrocolic) anastomosis and have recurrence rates respectively of 1–400 and 0–300. Wangensteen says that not only does a short loop give more rapid neutralization of such acid as is formed by the stomach remnant, but that the lower down the jejunum one goes, the more prone is the bowel to ulceration. The knowledge that the intestinal juices are essential for the protection of the anastomotic line even after a gastrectomy led Gordon-Taylor and Hudson in 1928 to condemn the 'en-Y' anastomosis on account of the high incidence of recurrent ulceration. Entero-anastomosis between the loops has also been given up.

Other figures of recurrent ulceration in relation to the two types of anastomosis are few and indefinite except in occasional incidences. Writers appear not to have segregated the long and short loops in relation to their recurrence rates. However, for what they are worth I quote the following results:—

Sanders (1945), using mainly antecolic full-width anastomosis after a 60 per cent resection for duodenal ulceration, gives an 8 per cent recurrence rate.

Keifer (1942) reported 11·4 per cent of gastrojejunal ulcers in 173 extensive gastric resections, using mainly an antecolic long loop.

Maingot, discussing the operation of pyloric exclusion, gives the low recurrence figure of 2 per cent in antecolic anastomoses. He actually prefers the retrocolic variety, saying it is more physiological, but does not hesitate to use the anterior if difficulty arises.

Strauss and others quote no recurrences in 221 cases of retrocolic anastomosis.

Richter (1934) says: "I believe the long loop . . . with or without entero-anastomosis adds a substantial danger of gastrojejunal ulcer. . . ."

Garnet Wright in 1934, discussing gastrojejunal ulceration, stresses that the anterior gastro-enterostomy is very much more prone to this complication than is the posterior variety. He was able to collect only a few cases of gastrectomy for duodenal ulcer, so few that the figures or recurrence rate are probably not reliable. They are: antecolic 0 per cent, retrocolic 2·59 per cent.

The present series, antecolic 3·3 per cent recurrences (92 cases), retrocolic 0 per cent recurrences (34 cases).

The idea that the routine use where possible of the short jejunal loop would still further reduce the incidence of recurrent ulceration, would seem to be worth while investigating further in a larger series of cases. The difficulties of the opening in the transverse mesocolon, and obstruction of the loops, might well be lessened by the modification in technique described by Lahey and Marshall (1939) whereby the afferent jejunal limb is considerably mobilized by division of the ligament of Treitz. In the few cases in which the writer has personally performed this modification, the results have been gratifying, and so far as can be judged from these very recent cases the functional after-effect is satisfactory. One must admit, however, that anomalies of the ligament of Treitz are common and it is not always easy to use this modification of the posterior anastomosis.

Speed of Emptying.—One other feature common to all three recurrences in this series was a wide stoma. X-ray examination and F.T.M. have confirmed that the stomach remnants empty readily and rapidly. Some American writers, e.g., Strauss and others and Sanders, emphasize that the rapid emptying of the stomach remnant gives greater protection against recurrent ulceration, mainly because more rapid neutralization of acid is effected. These three cases do not support that view, which does not seem to be widely held in Great Britain.

CONSIDERATION OF THE CASES SHOWING GASTRIC AND INTESTINAL UPSETS

1. Not Improved.—There were 4 cases in this section.

Case.—H. C., male, aged 50, seen 10 months after a three-quarter resection for a duodenal ulcer; an antecolic isoperistaltic anastomosis. This man was well for a month after operation, but since then has been completely incapacitated by distension pain after eating and by frequent regurgitations and vomiting of bile.

F.T.M.: No free acid. Diminished total acid. Bile present throughout. Emptying time 2½ hours.

Blood-count: Normal.

X-ray examination: No ulcer or hold-up (Dr. Lawson).

Gastroscopy: No ulcer or abnormality seen (Mr. McGavin). Is still on a strict ulcer diet. This man is definitely introspective, and it is probably this attitude

which is making his symptoms worse by delaying the normal readjustment of his gastro-intestinal tract. He is slowly improving with reassurance, rest, and sedatives.

Case.—R. H., male, aged 43, seen 3 years 1 month after an isoperistaltic retrocolic resection for gastric ulcer. Ever since his operation this man has had occasional vomits of bile. During the last year, possibly associated with a change of occupation, this is becoming worse, and he is now occasionally vomiting food.

F.T.M.: No free acid. Low total acid. Emptying time 2½ hours.

Blood-count: Normal.

X-ray examination: No evidence of afferent loop regurgitation (Dr. Lawson). Is eating normal food. This man did not appear to be neurotic.

Blood-count: Normal.

X-ray examination: No evidence of hold up or regurgitation (Dr. Lawson). Is eating normal food. This man is not neurotic.

These four cases will be considered with the next two groups.

2. 'Improved'.—This group of 15 patients had all benefited considerably from their operation, with which they said they were pleased, but all had some symptoms which caused them a certain amount of distress, and which in some cases had caused loss of work for short periods. (*Table II.*)

All had isoperistaltic anastomoses.

No. 1 and 15 had a pyloric exclusion.

Table II.—RECORDS OF 'IMPROVED' CASES

	Sex	Age	Ante- or Retro-colic	Original Lesion	Post-operative Time	Free Acid	Nature of Main Symptoms
1. T. L.	M.	38	A.	D.	2 yr. 2 mth.	0	Vomiting of bile occasionally. Used to be three times a day, but is improving
2. C. B.	M.	36	A.	D.	1 yr.	0	Fullness ++. Has lost work on this account. (Is of low intelligence)
3. J. B.	M.	47	A.	D.	7 mth.	Not done	Very occasional vomiting of bile
4. B. C.	F.	48	A.	G.	3 yr.	0	Vague fullness causing very occasional vomiting of food
5. T. D.	M.	33	R.	G.	5 yr. 9 mth.	Not done	Fullness, severe enough on occasions to have caused loss of work. (He is 'aggressive' to his stomach, and hurries his food)
6. C. G.	M.	54	R.	G.	5 yr. 9 mth.	Not done	Mild fullness. Occasional vomiting of bile
7. F. P.	F.	61	R.	G.	6 yr. 5 mth.	Not done	Fullness and nausea causing a stay in bed on occasions. Bad feeding habits
8. G. S.	F.	42	R.	G.	4 yr. 1 mth.	Not done	Distension pain ++. Occasional bile vomits.
9. A. F.	M.	44	A.	G.	1 yr. 3 mth.	0	Vomiting bile occasionally. Slight fullness pain.
10. E. V.	M.	42	R.	D.	1 yr. 1 mth.	0	Fullness. Vomits bile occasionally.
11. B. F.	F.	43	R.	D.	1 yr. 7 mth.	0	Fullness +. Vomits bile sometimes, but with lessening frequency
12. S. S.	M.	46	A.	G.	1 yr. 8 mth.	Not done	Feeling of faintness after meals. Vomits bile sometimes
13. A. H.	M.	45	A.	D.	1 yr. 1 mth.	0	Fullness ++. Occasional vomiting of food.
14. W. G.	M.	50	A.	G.	6 yr. 4 mth.	0	Vomits bile occasionally. Some loss of work
15. J. M.	M.	42	A.	D.	3 yr. 1 mth.	—	Very occasional vomiting of bile; at one time this symptom was severe.

Case.—H. D., male, aged 45, seen 6 years 8 months after a retrocolic, probably isoperistaltic, resection for gastric ulcer. A definite distension syndrome, persistent since operation, which has probably been aggravated by gross anæmia.

F.T.M.: No free acid. Low total acid. Emptying time ¾ hour.

Blood-count: 60 per cent Hb; 4,500,000 R.B.C.

X-ray examination: No ulceration, no regurgitation, no gastric delay (Dr. Lawson). Is eating small frequent meals, attempting to keep to a diet. This man is definitely not neurotic. With iron his anæmia showed rapid regression; at the same time he was advised to increase the bulk of his food; when seen 5 months later he looked very fit and assured me that the uncomfortable feelings after food were much improved.

Case.—T. P., male, aged 37, seen 1 year 1 month after an antecolic isoperistaltic resection for duodenal ulcer, in which a pyloric exclusion with excision of antral mucosa was carried out. A definite distension syndrome. He said that the operation had not benefited him.

F.T.M.: 15 c.c. free acid. Low total acid. Emptying time 2¾ hours.

No patient was anæmic.

Five were X-rayed and were reported on by Dr. Forbes Lawson as follows:—

No. 9, A. F.: "No ulcer. Barium goes into the afferent loop, but there is no obstruction to outflow."

No. 13, A. H.: "No ulcer. Spasm of stoma at beginning of examination. No regurgitation into afferent loop."

No. 10, 11, and 14 showed a normally functioning partial gastrectomy.

Thus ten of these patients were vomiting bile on occasions, and nine had symptoms of the post-cibal syndrome such as fullness pain, in some cases of distressing degree.

Since this review I have seen two more patients whose recovery is being retarded in like fashion; one is a male 9 months after operation who has bad distension pain, nausea, and a feeling of faintness immediately after eating. He is not improving, and for this reason has been maintaining a strict gastric

diet. There is no X-ray evidence of afferent-loop regurgitation, and there is no free acid in his gastric juice. He has been reassured and arrangements made for his food to be changed to a more normal constitution.

The second patient is a man four months after operation complaining of bile vomiting, which he says is getting worse. His was an antiperistaltic anastomosis; there is no abnormality to be found on examination.

3. 'Good'.—This group of patients (57) all experienced mild fullness or flatulence after eating, but in none was it a disabling symptom; most of them only gave the information on direct questioning.

Discussion.—It is well known that, soon after operation, patients not uncommonly experience disagreeable sensations on taking food, usually solids, but sometimes liquids. It is well to warn the patient of these symptoms and to advise him to build up the volume of his meals gradually; I have recently spoken to two patients not in this series, who, about six weeks after operation, were becoming very worried on account of those symptoms. After explanation and advice they improved and are now doing well.

Usually, the post-cibal syndrome disappears fairly rapidly, but time does not cure every case, as has been pointed out before by Waugh and others, quoted by Berkman and Heck (1945). Presumably the gastro-intestinal tract becomes accustomed to the new conditions, and Berkman and Heck raise the point that in order that the stomach and jejunum may become accustomed to normal food it is important that the diet of these patients should be gradually but surely changed from the soft non-irritating gastric-diet foods to the more bulky foods of a normal diet, and that they should not be deterred from doing so by the post-cibal sensations. They also maintain the importance of a sufficient calorie intake in the immediate post-operative period in order to ensure the well-being of the patient, and speed his recovery.

Few writers have mentioned bile vomiting as a symptom after gastrectomy, but many have noted the post-cibal syndrome of fullness and wind, a heavy feeling in the epigastrium, sometimes nausea, with fainting or sweating, and some, e.g., Berkman and Heck, have pointed out that this syndrome may be more disabling than recurrent ulceration, as it was in 4 cases in this series. In the present group of cases bile vomiting was noted in 12, and fullness, sweating, etc., in 68 in varying degrees.

There are three possible causes for the post-cibal syndrome: (1) The small size of the stomach stump. (2) Reflux into the afferent jejunal loop. (3) 'Dumping' into the jejunum.

The Size of the Stomach.—Distension of the apparently small stomach stump is, I believe, usually not the cause of symptoms for the following reasons: I have observed identical symptoms in 4 patients after total gastrectomy. Many observations after gastrectomy have pointed out the great speed with which the stomach empties. Hence, in this series, 31 of 45 fractional test-meals have indicated complete emptying in not more than 1½ hours.

Dr. Forbes Lawson has not seen any evidence of gastric delay in the cases in this series, although all these patients who were X-rayed had symptoms suggestive of possible delay.

Vitkin (1940) says that the stomach is empty in 20 minutes, often sooner. Strauss and others (1930) say that in their series an emptying time of less than 50 minutes is usually present.

Shanks says that all partial gastrectomies empty more rapidly than the normal stomach, the Polya being most rapid.

Schmidt and Melick (1945) mention "immediate emptying" in 17 of 21 cases examined radiographically. Further, there is much evidence that the stomach stump will expand and approach the size of an 'average' stomach, if there exists such a stomach. Thus in this series the stomach has been usually seen to be of "reasonable" size. Shanks gives an X-ray picture after a Polya–Lake gastrectomy in which the stomach is quite large, and Vitkin says that at the end of one year only 9 of 45 patients examined radiographically had a stomach smaller than 'average' size.

In this review only a few patients stated that their meals were of necessity of smaller volume than normal, although many restricted the volume of food in order to lessen the post-cibal symptoms. By so doing they managed to lead to all intents and purposes a normal life.

Reflux to the Afferent Loop.—Many surgeons believe that the post-cibal syndrome is due to reflux of food into the duodenum and afferent loop (Ogilvie, 1935; Lake, 1937; Maingot, 1940; Marshall, 1944; Wangensteen, 1945; Ingelfinger, 1945; Monro, 1945).

Undoubtedly duodenal reflux is of common occurrence, but in the absence of obstruction to the outlet of the afferent loop, it does not give rise to symptoms. Radiologists have frequently noted the backflow without obstruction and have seen that the duodenum is of normal calibre. In cases where this backflow is the cause of post-cibal distension and vomiting, there is a mechanical obstruction to the outflow from the afferent loop, due to faulty technique, usually in using too short a loop, or in twisting the loop, or obstruction on passing through the mesocolon in a retrocolic anastomosis. The surgeons mentioned above and many others (Lahey and Marshall, Richter, Kiefer, Finsterer, and Cunha) use the Finsterer-Hofmeister modification whereby about half of the cut end of the stomach is closed, leaving a smaller stoma near the greater curvature, for anastomosis to the efferent jejunal loop. The afferent loop is hitched to the lesser curve. By this means these surgeons believe reflux into the afferent loop is rendered much less likely.

In this particular series I do not believe that the afferent loop reflux has been the cause of symptoms, for the following reasons: The discomfort has always been central epigastric, rather than on the right side; there has been X-ray evidence of reflux without obstruction to outflow in one case only, despite the fact that some degree of reflux is a not uncommon normal finding; where vomiting has occurred, food has rarely been seen.

I have, however, recently seen one patient not included in this series, since his operation was only four months old, whose present symptoms are due to afferent-loop obstruction. He had an antecolic

isoperistaltic Polya gastrectomy for gastric ulcer, and said that he was well for one month after operation, but then began to vomit each morning, usually one hour after a glass of milk, the vomit consisting of half a pint or more of bright-green fluid, not containing food, and not recurring at other times of the day. X-ray examination by Dr. Lawson revealed distension of the afferent loop without complete obstruction, but resulting in some delay in the progress of the meal; he noted a suggestion that the jejunal segment was perhaps twisted. It will be noticed that this man's symptoms are rather different to those of the usual post-cibal syndrome.

Jejunal 'Dumping'.—This is, to-day, the commonly accepted cause of most of the unpleasant symptoms after gastrectomy. Samson Wright, discussing the effect of distension of the upper jejunum, says that symptoms similar to those caused by distension of the duodenum are produced: "There is a sensation of pressure, dull and heavy in character, deep seated and poorly localized anteriorly between the xiphoid and umbilicus; at still higher pressure there is a disagreeable painful or griping feeling."

The description of this sensation is very similar indeed to that given by a number of the patients interviewed, and I believe that it is the sudden entry of food in fairly large quantities which mimics these experiments and causes upsets in some patients; we do know that the stomach, as a rule, empties rapidly. This sensation certainly distresses some patients in early post-operative times, even when they are warned about the possibility as they should be. It is also often accompanied by vasomotor phenomena, which Samson Wright also describes.

That the post-cibal syndrome is not to be dismissed lightly, and that the figures in this series represent its approximate incidence, are shown by reference to other series. Berkman and Heck (1945) quote several sets of figures, e.g., Mateer 14 per cent; "not infrequently" in 240 cases by Miller; "sufficient numbers to be noticeable" in 104 cases by Church and Hinton; 5·6 per cent and 12·5 per cent in large series by Carter, Butt, and Waugh. Ingelfinger (1944) says that probably 10 per cent of patients suffer the post-cibal syndrome, although he points out that the published figures vary considerably.

Since it is not possible to re-form a sphincter after partial gastric resection, it is suggested that possibly a reconstruction of the Hofmeister-Finsterer valve type might help to do away with some of this jejunal dumping, by narrowing the entrance to the jejunum and offering a purely mechanical barrier to the rapid filling of the bowel.

In looking through the literature, I have come across the following references to clinical results in regard to size of stoma: As far as I have been able to ascertain, the figures quoted by Berkman and Heck referred to results in the Polya 'wide-stoma' anastomosis. Morley (1928) remarks that he finds the Schoemaker operation to give better "clinical results" than the Polya. Louria (1928) mentions 128 excellent results out of 158 gastrectomies, which were of the Billroth I or II type; 25 patients complained of fullness but were greatly improved; only 5 were not improved. Finsterer and Cunha (1931), using the Hofmeister method, quote out of 307 cases only 4 who experienced gastric distress. The whole group were more than three years post-operation.

Ogilvie (1935) has not seen "post-operative vomiting or distension even in a minor degree" in over 100 anastomoses of the Finsterer type. He had previously remarked upon its not infrequent occurrence after a full-width anastomotic line.

Ingelfinger (1944) says 10 per cent of patients suffer the post-cibal syndrome, although he thinks that the size of the stoma plays very little part in the picture, but that ability of the bowel to adjust itself is more important.

Marshall (1944) says that the Polya–Moynihan operation is commonly followed by 'dumping' into the jejunum and duodenal reflux. He says the stoma should be a little larger than gut calibre, and fashioned in a Hofmeister anastomosis.

Pallin (1932) attributes many unsatisfactory results after the Billroth II to precipitate emptying of the stomach. He says that the Billroth I is superior on these grounds.

In Vitkin's cases, where the incidence of post-operative symptoms was low, the anastomosis was of the Hofmeister type. Vitkin says that in this group it was very often noticed that the first of the barium meal went straight into the afferent loop, but that the remainder was to some extent held in the stomach, and evacuated rhythmically, mainly due to bowel peristalsis.

Waugh, quoted by Berkman and Heck (1945), had recently used the Hofmeister valve modification of the Polya in a few cases, and had an impression that the results were better than the full-width type of stoma which he had previously used.

Maingot (1945) uses the Polya-Hofmeister operation for several reasons, one of which is that "post-operative obstructive symptoms and the sensation of fullness after meals are obviated".

Bile Vomiting.—I believe that it is the rapid emptying of the stomach due to the size of the anastomosis which is responsible for the vomiting of bile in some of these patients. The response of the gall-bladder to the ingestion of food is a contraction almost immediately; in a Polya anastomosis, by the time this bile reaches the stomach, it is empty; and it would appear that in some patients, bile acts as a strong irritant to the gastric mucosa, leading to regurgitation and vomiting; in this series only very rarely was food vomited with bile.

References to this type of upset in the literature are few, but McClure and Fallis (1940, a, b) say the Hofmeister-Finsterer-valve technique is of value in deflecting upper intestinal contents past the gastric stoma; they have gained confirmation of this impression by the fact that a good deal less bile is aspirated post-operatively when this type of anastomosis is used. This observation agrees with my own personal knowledge of this type of anastomosis. They also say that "since adopting this technique our patients have not complained of occasional regurgitation of bile, as not infrequently occurs during convalescence after the Polya operation".

It is realized that the figures quoted above are by no means conclusive in showing that a small stoma may improve some of the bad end-results after gastrectomy, and the picture is further complicated

by recent work mentioned previously, which suggests that interference with pressure gradients between stomach and small bowel may be a main factor in dealing with the post-cibal syndrome. Nevertheless, I feel that investigation on similar lines of a fairly large series of cases, using a small anastomosis, would be very useful.

THE FRACTIONAL TEST-MEAL

Seventy-one fractional test-meals have been carried out in the course of this review. The test is carried out after a fast for twelve hours; the fasting juice is then aspirated, after which a pint of gruel is drunk and the stomach contents aspirated every quarter of an hour. It has been the practice to stimulate the flow of hydrochloric acid by the injection subcutaneously of 0·0001 mg. of histamine should the fourth specimen of juice fail to contain free acid.

Certain features have been common to all the test-meals: Mucus has been present in all specimens in all cases. Bile has been present in all specimens in most of the cases. All have shown a lowered total acidity, indicating an actual diminution in the quantity of gastric juice secreted.

The test-meals are divisible into two main groups: 49 in which the ulcer, whether gastric or duodenal, was removed completely; I have called these 'routine' gastrectomies. The other group consists of 22 in which the modern modification of pyloric exclusion for duodenal ulcer has been carried out.

Forty-nine Test-meals after Routine Gastrectomy.—The findings in this group have confirmed the usual findings after partial gastrectomy, i.e., most of the cases have failed to show the presence of free hydrochloric acid and all have shown a diminished total acidity. Only 7 showed free acid (*Table III*, *Fig.* 511).

Table III.—CASES SHOWING FREE ACID AFTER PARTIAL GASTRECTOMY

NAME	SEX	AGE	ORIGINAL LESION	POST-OPERATIVE TIME	HIGHEST FREE TOTAL ACID	CLINICAL RESULT
C. B.	F.	48	Gastric	7 mth.	10/25 c.c.	Good
C. B.	M.	38	Duodenal	1 yr.	5/25 c.c.	Improved
A. M.	F.	67	Pyloric	1 yr. 7 mth.	10/28 c.c.	Good
H. S.	M.	49	Duodenal	2 yr. 11 mth.	5/22 c.c.	Good
V. R.	F.	48	Duodenal	3 yr. 3 mth.	20/35 c.c.	Good
C. Br.	M.	56	Duodenal	3 yr. 9 mth.	12/20 c.c.	Excellent
W. M.	M.	47	Gastric	6 yr. 10 mth.	8/35 c.c.	Excellent

The remaining 42 are listed in *Table IV*, and are typically illustrated by the two graphs, *Figs.* 512, 513.

Several points emerge from these figures:—

Despite the well-known fact that a duodenal ulcer is usually associated with a much higher acidity than a gastric ulcer, the remnant of stomach after operation does not appear to behave differently in the two types. It must be agreed, however, that the test-meal is not a very accurate estimation.

Length of time after operation would appear to make no difference to the acid-secreting capabilities of these post-operation stomachs. Most of the results indicate rapid emptying, but there does not appear to be any relation between the rate of emptying and the functional result.

Table IV.—TEST-MEALS IN THE REMAINING 42 CASES

NAME	SEX	AGE	POST-OPERATIVE TIME	HIGHEST TOTAL ACID	EMPTYING TIME	CLINICAL RESULT
After Gastrectomy for Gastric Ulcer:—						
G.B.	M.	65	1 yr. 1 mth.	32 c.c.	1 hr.	Good
A. F.	M.	41	1 yr. 3 mth.	35 c.c.	¾ hr.	Improved
M. W.	F.	60	1 yr. 4 mth.	28 c.c.	¾ hr.	Good
J. D.	M.	45	1 yr. 5 mth.	32 c.c.	½ hr.	Good
J. Dl.	M.	44	1 yr. 6 mth.	13 c.c.	1½ hr.	Good
A. C.	M.	63	1 yr. 10 mth.	18 c.c.	1¼ hr.	Excellent
J. J.	M.	56	2 yr. 1 mth.	22 c.c.	2¼ hr.	Good
P. B.	M.	35	2 yr. 4 mth.	25 c.c.	1¾ hr.	Good
T. H.	M.	67	2 yr. 4 mth.	10 c.c.	¼ hr.	Good
G. R.	M.	69	2 yr. 9 mth.	22 c.c.	¾ hr.	Excellent
L. S.	F.	42	2 yr. 10 mth.	28 c.c.	¼ hr.	Excellent
B. C.	F.	51	3 yr.	25 c.c.	1½ hr.	Improved
R. H.	M.	42	3 yr. 1 mth.	22 c.c.	2½ hr.	Not improved
K. F.	F.	60	3 yr. 7 mth.	31 c.c.	¼ hr.	Good
S. P.	M.	49	3 yr. 8 mth.	20 c.c.	¾ hr.	Good
W. D.	M.	51	4 yr. 1 mth.	22 c.c.	1½ hr.	Good
A. S.	M.	66	4 yr. 3 mth.	20 c.c.	1¼ hr.	Good
W. T.	M.	56	4 yr. 5 mth.	27 c.c.	1¼ hr.	Good
W. G.	M.	57	6 yr. 4 mth.	25 c.c.	1½ hr.	? Improved
H. D.	M.	39	6 yr. 8 mth.	30 c.c.	¾ hr.	Not improved
E. W.	F.	55	7 yr. 5 mth.	20 c.c.	¼ hr.	Excellent
After Gastrectomy for Duodenal Ulcer:—						
A. H.	M.	46	1 yr.	45 c.c.	1 hr.	Improved
H. C.	M.	50	10 mth.	22 c.c.	2½ hr.	Not improved
E. K.	M.	44	1 yr. 2 mth.	15 c.c.	¼ hr.	Improved
A. F.	M.	51	1 yr. 3 mth.	15 c.c.	1½ hr.	Excellent
A. L.	M.	41	1 yr. 4 mth.	18 c.c.	2¾ hr.	Good
M. Q.	M.	35	1 yr. 6 mth.	22 c.c.	1 hr.	Excellent
A. F.	F.	45	1 yr. 7 mth.	20 c.c.	¼ hr.	Improved
C. M.	M.	41	1 yr. 7 mth.	32 c.c.	2 hr.	Excellent
H. W.	M.	50	1 yr. 8 mth.	23 c.c.	¼ hr.	Recurrence
E. T.	M.	41	1 yr. 9 mth.	25 c.c.	1½ hr.	Excellent
M. G.	F.	47	2 yr.	23 c.c.	2¾ hr.	Good
A. B.	M.	51	2 yr.	20 c.c.	1¼ hr.	Good
E. C.	F.	43	2 yr. 1 mth.	30 c.c.	2¾ hr.	Good
G. D.	M.	45	2 yr. 3 mth.	27 c.c.	2¾ hr.	Excellent
H. B.	M.	42	3 yr. 5 mth.	27 c.c.	1¼ hr.	Good
W. W.	M.	45	3 yr. 10 mth.	30 c.c.	½ hr.	Good
C. M.	M.	42	4 yr.	12 c.c.	¾ hr.	Recurrence
H. B.	M.	39	4 yr. 4 mth.	27 c.c.	½ hr.	Good
C. B.	M.	46	6 yr.	12 c.c.	¼ hr.	Good
C. P.	M.	42	6 yr. 9 mth.	15 c.c.	1¼ hr.	Good
After Stomal Ulcer:—						
S. H.	M.	51	1 yr. 6 mth.	30 c.c.	1¾ hr.	Good

Twenty-two Test-meals after Gastrectomy with Pyloric Exclusion.—This operation is the modern derivative of the method originally devised by Finsterer in 1918 for use where the state of the duodenum rendered removal of the ulcer dangerous. It now consists of division of the stomach through the pyloric antrum, preservation of the seromuscular layer, and excision of the mucosa as far as the sphincter, the ulcer being left in situ.

Of the 22 test-meals, 14 have shown the presence of free acid (*Fig.* 514). In addition to this high incidence of free acid, the other interesting feature is that most of them show a much higher quantity of both free and total acid when compared with those test-meals showing free acid after routine gastrectomy.

Table IV shows the results in this group.

The Results of the Operation of Pyloric Exclusion (*Table VI*).—The fractional test-meals after pyloric exclusion are at such variance with those following routine gastrectomy that one feels that they must have some significance. If one believes that

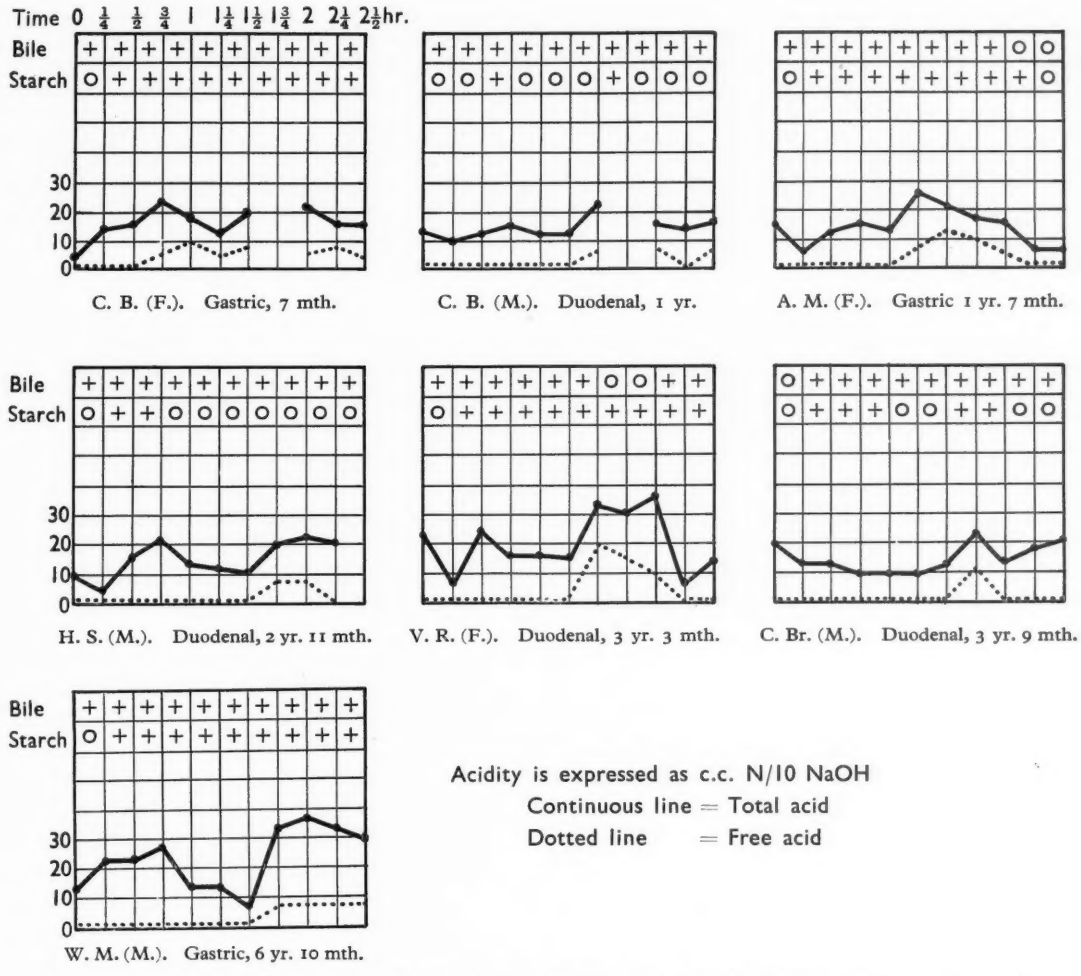
Time 0 ¼ ½ ¾ 1 1¼ 1½ 1¾ 2 2¼ 2½hr.
Bile
Starch
30
20
10
0
C. B. (F.). Gastric, 7 mth.
C. B. (M.). Duodenal, 1 yr.
A. M. (F.). Gastric 1 yr. 7 mth.
H. S. (M.). Duodenal, 2 yr. 11 mth.
V. R. (F.). Duodenal, 3 yr. 3 mth.
C. Br. (M.). Duodenal, 3 yr. 9 mth.
W. M. (M.). Gastric, 6 yr. 10 mth.
Acidity is expressed as c.c. N/10 NaOH
Continuous line = Total acid
Dotted line = Free acid

FIG. 511.—Fractional test-meal charts of seven patients after 'routine' partial gastrectomy, showing free acid.

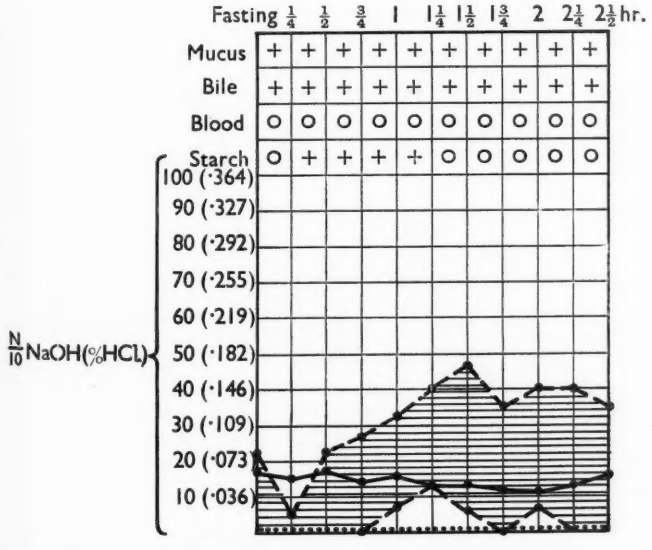

FIG. 512.—A. H., male, 63 years. Gastric ulcer. 1 yr. 10 mth. post-operation.

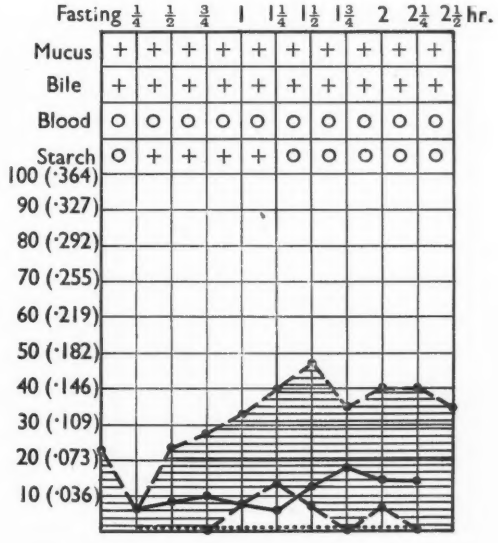

FIG. 513.—C. P., male, 42 years. Duodenal ulcer. 6 yr. 9 mth. post-operation.

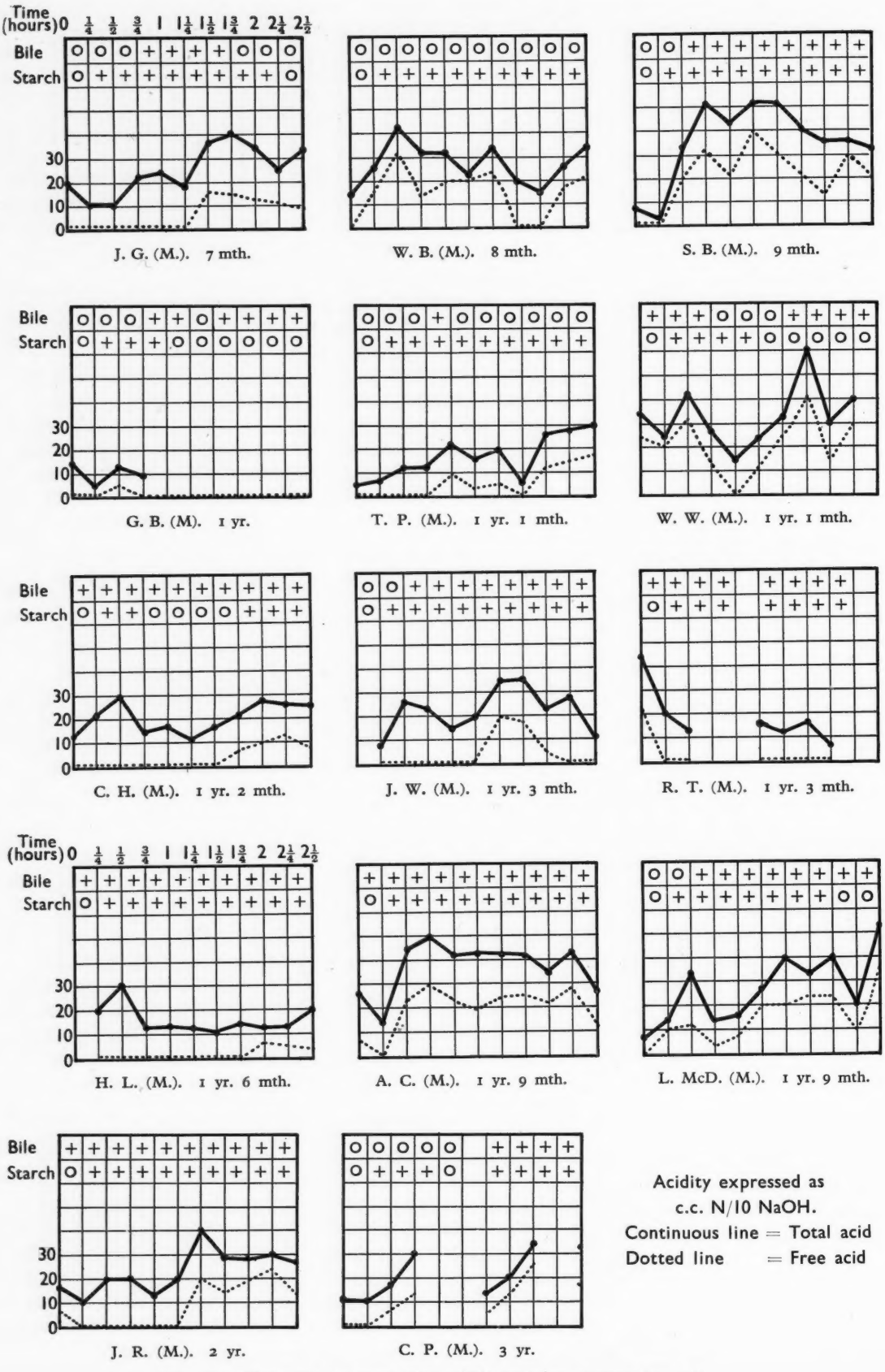
Time (hours) 0 ¼ ½ ¾ 1 1¼ 1½ 1¾ 2 2¼ 2½
Bile
Starch
30
20
10
0
J. G. (M.). 7 mth.
W. B. (M.). 8 mth.
S. B. (M.). 9 mth.
G. B. (M). 1 yr.
T. P. (M.). 1 yr. 1 mth.
W. W. (M.). 1 yr. 1 mth.
C. H. (M.). 1 yr. 2 mth.
J. W. (M.). 1 yr. 3 mth.
R. T. (M.). 1 yr. 3 mth.
H. L. (M.). 1 yr. 6 mth.
A. C. (M.). 1 yr. 9 mth.
L. McD. (M.). 1 yr. 9 mth.
J. R. (M.). 2 yr.
C. P. (M.). 3 yr.
Acidity expressed as
c.c. N/10 NaOH.
Continuous line = Total acid
Dotted line = Free acid

FIG. 514.—Test-meals (14 cases) after pyloric exclusion, showing free acid.

recurrence of ulceration is at least associated with the presence of free hydrochloric acid, then one might say that the incidence of recurrence in this group would be higher. Fortunately this seems not to be so, although most of the cases are of fairly recent post-operation date.

Table V.—DETAILS OF 22 CASES AFTER GASTRECTOMY WITH PYLORIC EXCLUSION

POST-OPERATIVE TIME	HIGHEST FREE TOTAL ACID	CLINICAL RESULT	EMPTYING TIME
14 Cases with Free Acid (all males) :—			
7 mth.	18/40 c.c.	Improved	2¾ hr. +
8 mth.	30/40 c.c.	Very good	2¼ hr. +
9 mth.	40/55 c.c.	Excellent	2¾ hr. +
1 yr.	5/15 c.c.	Excellent	1 hr.
1 yr. 1 mth.	15/30 c.c.	Poor	2¾ hr. +
1 yr. 1 mth.	45/60 c.c.	Very good	1¼ hr.
1 yr. 2 mth.	10/30 c.c.	Excellent	2¼ hr. +
1 yr. 3 mth.	20/37 c.c.	Excellent	2¾ hr. +
1 yr. 3 mth.	20/42 c.c.	Good	2¼ hr.
1 yr. 6 mth.	5/30 c.c.	Very good	2¾ hr. +
1 yr. 9 mth.	30/50 c.c.	Very good	2¾ hr. +
1 yr. 9 mth.	38/52 c.c.	Excellent	2 hr.
2 yr.	22/40 c.c.	Good	2¼ hr.
3 yr.	20/35 c.c.	Recurrence	2¾ hr. +
8 Cases without Free Acid (all males) :—			
10 mth.	32 c.c.	Very good	1 hr.
1 yr. 3 mth.	10 c.c.	Good	2 hr.
1 yr. 4 mth.	12 c.c.	Excellent	1¾ hr.
1 yr. 7 mth.	20 c.c.	Excellent	1¼ hr.
2 yr. 2 mth.	40 c.c.	Improved	1¼ hr.
2 yr. 4 mth.	28 c.c.	Good	½ hr.
2 yr. 8 mth.	23 c.c.	Good	1¼ hr.
2 yr. 10 mth.	25 c.c.	Excellent	1¾ hr.

Table VI.—RESULTS IN 30 CASES AFTER PYLORIC EXCLUSION

Excellent	14	46·7 per cent
Good	11	36·7 per cent
Improved	3	10 per cent
Not improved	1	3·3 per cent
Recurrence	1	3·3 per cent

All modern writers are agreed that Finsterer's original method of pyloric exclusion whereby the mucosa of the pyloric antrum is preserved is bad; not only is it technically difficult, but it is dangerous should pyloric stenosis occur, and it is physiologically unsound since it preserves that area of mucosa which is the main source of the hormone gastrin, the chief acid-secreting stimulus. Hence the modern operation (Finsterer, 1931; Ogilvie, 1938; Maingot, 1941) of division through the pyloric antrum and excision of the pyloric mucosa has been devised, with, apparently, great success.

Thus Maingot quotes only 2 per cent of recurrences after this operation; he does not indicate the frequency of free hydrochloric acid. Finsterer and Cunha (1939) quote a similar figure, but again make no reference to acidity. Walton (1941) believes that division of the duodenum beyond the ulcer is not necessary. Lannin (1945) gives experimental evidence in dogs that removal of the duodenal mucosa is of no great significance provided the antral mucosa is removed. Wangensteen (1945) says that his observations suggest that it is not necessary to remove the duodenal ulcer itself to prevent ulcer recurrence. It seems that there are two possible reasons for the higher incidence of free acid in this group of cases. The more likely is that not all the mucosa of the pyloric antrum has been removed; this had definitely occurred in a case of recurrent ulceration reported by Wangensteen, in which the ulceration had remained healed for five years following excision of the fragment of mucosa.

Another possible reason is that in these cases the whole of the first part of the duodenum is preserved, whereas in the routine gastrectomy probably more than half is removed or destroyed. Samson Wright says that the hormone gastrin is manufactured in the duodenum; presumably this would occur in the first part.

Should the good results of this group of cases be maintained, as seems possible from a review of the literature and from the small number of cases in this series over two years after operation, then at least it will definitely do away with the common belief that free acid is a usual precursor of recurrent ulceration after gastrectomy. Holmes and McSwain, for instance, say: "... up to the present time all marginal ulcers in this clinic occurred in patients with adequate (post-operative) acidity". In Kiefer's series of 20 recurrences after gastrectomy, free acid was present in 17.

Conclusion.—The presence of this free acid is rather alarming, and suggests that until we know more about the exact role of free acid in peptic ulceration, pyloric exclusion should not become a routine operation. The operation is undoubtedly a great help, and has contributed a large share to lowering the mortality in duodenal ulceration, yet one feels that possibly six to eight weeks' strict medical therapy before operation in patients with much pain, by lessening the inflammatory reaction around the active ulcer, and by lessening the formation of adhesions, would render the complete removal of a duodenal ulcer a more practicable procedure, and thereby might help to lower the incidence of the necessity for this type of gastrectomy.

Should the fear of recurrent ulceration in this group of cases be found to be real, as time will define, then the operation of pyloric exclusion would still have a prominent place in the treatment of duodenal ulcer. The surgical treatment would then consist of a two-stage procedure in which the first stage would be a high gastrectomy with the old-type pyloric exclusion, to be followed after an interval of a few weeks by resection of the pylorus and duodenum. A very successful series of this type has recently been reported by McKittrick, Moore, and Warren (1944). They said that six to twelve weeks after the first stage the duodenum had healed and settled down and could be excised easily.

ANÆMIA

The standards for normal hæmoglobin and red blood-cells are those adopted by Whitby and Britton (1940) as follows:—

Hæmoglobin is expressed as a percentage according to the Haldane scale (13·8 g. Hb per cent).

Lowest normal for the male	100 per cent Hb 5,000,000 R.B.C.
Lowest normal for the female	85 per cent Hb 4,500,000 R.B.C.

On these values, 17 out of 127 patients examined were found to be anæmic. Of these 17, 3 have been

excluded, since they were suffering from other conditions which were almost certainly causing their anæmia—two men with hæmorrhoids, and one woman with menorrhagia due to fibroids; one of the men is known to be improving after treatment for his hæmorrhoids. This gives an incidence of 14 in 127, i.e., 11 per cent.

The sex incidence is as follows :—

Males	10 of 107 (9·3 per cent)
Females	4 of 20 (20·0 per cent)

All except one of these anæmias were of the hypochromic microcytic variety. The one appeared at first to be a pernicious anæmia in that the colour index was high and the cells appeared large; there were, however, no abnormal red cells to be seen, and his ready response to iron confirmed the opinion that he was an unusual form of iron-deficiency anæmia.

Four, two men and two women, of the 14 might be described as severe anæmias, having hæmoglobin less than 60 per cent.

The cases have been divided by the three years' post-operation time into the following two groups :—

Longer than Three Years' Post-operation :—

Original lesion	Duodenal	Gastric	Stomal
No. of cases	13	23	1
No. of anæmias	2	5	0

i.e., of 37 cases, 7 were anæmic (18·1 per cent). The four severe anæmias were in this group.

Less than Three Years' Post-operation :—

Original lesion	Duodenal	Gastric	Stomal
No. of cases	50	36	4
No. of anæmias	1	6	0

i.e., of 90 cases, 7 were anæmic (7·7 per cent).

The tables do support the clinical impression that the anæmia is of slow progress and likely to become severe in later years.

Another interesting feature is that 11 of the 14 anæmias were in-patients originally suffering from a gastric ulcer; as follows :—

Duodenal 63	Gastric 59
Anæmias 3 (4·7 per cent)	Anæmias 11 (18 per cent)

All 14 anæmic patients had no complaints as regards their anæmia except 1, a woman who had been referred to hospital on account of dysphagia and shortness of breath.

Clinical Picture.—The impression gained on seeing these patients and their blood-counts is of a very slow but definite progress of anæmia; its slowness renders it hardly noticeable at all to the patient, as witness the man, W. M., aged 39, a farm labourer, who presented a most interesting picture; he had been working hard since his operation nearly seven years ago, and indeed appeared on examination to be fairly well except for a slight pallor; his hæmoglobin was found to be 26 per cent. He improved amazingly on treatment with iron for a short time.

Ten patients were eating normal food, 4 said they were on a 'diet'. Investigation of two of the diets by the dietitian indicated that they were not deficient in iron-containing food. Three of these had maintained their diet for over six years and their hæmoglobins were three of the lowest—38 per cent (female), 20 per cent (male), 58 per cent (male). The fourth of the severe anæmias, 49 per cent (female), had been dieting for over two years post-operatively. Despite the dietitian's investigation of two of these cases there does seem to be a predisposing factor here. Monro (1945) says that anæmia is almost unknown since recognition of the fact that post-operative dieting is not necessary.

Free Acid in Fractional Test-meal.—Of the 14 patients showing anæmia, fractional test-meals were carried out on 13; 3 showed the presence of free acid, two of them in patients with hæmoglobin of 49 per cent (female) and 26 per cent (male). All other fractional test-meals showed a reduction in the total chlorides, indicating at least a reduction in total acid secretion, even though not necessarily complete anacidity.

Response to Iron.—The response to iron has been remarkable. Nine patients have been observed and all have shown an extremely good and rapid response to iron, either as ferrous sulphate or as ferri et ammonium citrate, within a short period—usually an obvious reticulocyte response has been observed within a month.

The above observations indicate a disadvantage of the Polya operation, in that despite the secretion of free acid, its good value as regards the absorption of iron is immediately lost by very rapid neutralization by intestinal secretions, as evidenced by the invariable presence of bile in fasting juices, and do suggest that, in order that the small quantity of iron necessary to prevent anæmia shall be absorbed, the food of these patients has to contain a relatively high quota of iron, an indication for getting the patient on to a normal diet as soon as possible.

Pre-operative Anæmia.—Morley (1928), discussing anæmia after gastrectomy for gastric ulcer, says: "This tendency to anæmia was most noticeable in those who were anæmic at the time of operation as a result of pre-operative hæmatemesis".

The figures of pre-operative anæmia in this series, where known, are shown below; the relation to previous hæmatemesis is not known; only one was severe, most of them having been dealt with by blood transfusion pre-operatively.

Not anæmic before operation 96	Post-operation anæmia 5 (5·3 per cent)
Anæmic before operation 20 (one severe)	Post-operation anæmia 7 (35 per cent)

These figures support Morley's suggestion that pre-operation anæmia constitutes a handicap to recovery of a normal blood-count—they do show, however, that a pre-operation anæmia can be recovered from, a fact which had already been noted after examination of some immediate post-operation blood-counts which were low, and which had shown a rise to normal when examined.

Clinical Results in Anæmic Patients.—The clinical results were as follows :—

Excellent	4
Good	7
Improved	0
Not improved	1
Recurrence	1

These agree with most of the results recorded in the literature, i.e., that the functional element of the stomach is independent of the blood-picture, although in two cases (C. M., a recurrence; H. D., not improved) the anæmia did appear to be aggravating the gastro-intestinal upset. The latter's symptoms improved considerably when his anæmia was treated.

Review.—Since Deganello in 1900 reported a case of microcytic anæmia after an almost total gastrectomy, anæmia has been to the fore as a complication of gastric operations, especially resection. A review of the literature reveals two features about this complication after partial gastrectomy for simple ulcer: (1) Pernicious anæmia is rare; (2) The incidence of hypochromic anæmia varies considerably in different series of cases.

Pernicious Anæmia.—Lake (1937) found no cases of pernicious anæmia in over 300 partial gastrectomies; Ogilvie (1935) none in 140; Vaughan (1932) quotes only 9 cases recorded up to that date. In this series there were no cases in 127.

Other series also indicate the very occasional occurrence of this variety, and the incidence is so low as to suggest that its presence is often probably coincidental.

Hypochromic Anæmia.—Has long been recognized as a complication after an otherwise successful partial gastrectomy, but the records give a confusing idea of the incidence, thus :—

Gordon-Taylor	(1928)	23 out of 52 cases
Morley	(1928–9)	16 out of 42 cases
Strauss et al.	(1930)	1 out of 221 cases
Berg	(1930)	0 out of 400 cases
Louria	(1928)	None were mentioned in 129 cases
Larsen	(1934)	31 out of 86 cases
Reider	(1934)	39 out of 162 cases
Ogilvie	(1935)	"No cause for investigation re anæmia in 140 cases"
Semb	(1937)	25 per cent in males, 70 per cent in females (250 cases)
Lake	(1937)	Over 300 cases, "mild microcytic anæmia follows in some cases"
Manizade	(1937)	2 out of 40 (all over 5 years after operation)
Ingelfinger	(1944)	"Hypochromic anæmia is not uncommon"
Present series	(1946)	14 out of 127 cases (11 per cent)

I believe that the figure of approximately 10 per cent in the present series indicates the probable incidence. It seems likely that the insidious progress of the anæmia has caused it to pass without notice in some of the above series.

Morley believes that the Polya operation causes a higher percentage of anæmias than does the Schoemaker type. This is to be expected when the absorption of iron from the gastro-intestinal tract is considered; iron is absorbed from the least alkaline part, i.e., the first half, of the duodenum. Other writers, e.g., Larsen (1934) and Reider (1934), have not noted the discrepancy between the two types of operation. Incidentally, Morley's and Gordon-Taylor's series in which the anæmia was common, both consisted mainly of operations for gastric ulcers. The present series does not support this condemnation of the Polya operation for all types of ulcer, but certainly does give that idea when considered as the operation for gastric ulcer. The suggestion I have to offer for this discrepancy between duodenal and gastric ulcer results is connected with the usual difference in the amounts of free hydrochloric acid found pre-operatively in the two groups of cases.

Test-meals have shown no increased secretion of free or total acid in the duodenal cases; however, the post-operative fractional test-meals in the Polya operation can only be a coarse guide to the presence of acid, it is easy for the tube to withdraw jejunal secretion, and it would seem to me that the stomach of a duodenal ulcer post-operatively would still tend to secrete more acid than a similar remnant of a stomach from a gastric ulcer. Some writers, e.g., Holman and McSwain, have noted a difference in the two groups, 'duodenal' stomach remnants having been the chief offenders in secreting acid.

Summary.—Hypochromic anæmia is definitely a complication of partial gastrectomy, but not sufficiently frequent to cause the operation to be condemned on that account. It is more common after gastric ulcer.

Is almost always of the microcytic type.

Is usually of mild degree but may become severe if not treated.

Whether mild or severe, response to iron is excellent.

Diet for prolonged periods may be a predisposing factor.

The anæmia is insidious and often causes no complaints.

Females are more prone than males.

Is not related to the presence or absence of free hydrochloric acid.

Pre-operative anæmia is not irrecoverable.

The clinical result does not depend upon the blood-picture.

It behoves the practitioner to be well aware of the possibility of anæmia in a patient after a Polya gastrectomy for gastric ulcer.

CONCLUSION

In looking through this collection of cases and the literature, as has just been done, one realizes that whilst partial gastrectomy has been, and must for some time continue to be, a great boon to a very large number of patient's, there is still a residuum of cases after this operation which are not improved. Some suffer intensely from the post-cibal syndrome, and I have attempted to show that perhaps the small stoma will still further lessen this group.

Other cases suffer recurrent ulceration, and whilst the amount of stomach to be removed has not been discussed, I believe it should not be less than 60 per cent; the question of the length of loop needs further investigation clinically, but there is evidence to suggest that the shorter the loop, the greater the safety from ulceration.

The operation of pyloric exclusion even in its modern form is still not free from criticism from the point of view of post-operative acidity.

Anæmia has long been held up as a major complication after partial gastrectomy, and I hope that the cases in this series will have reduced this bogy to its correct lowly place.

I wish to thank all the members of the staff of the Leicester Royal Infirmary for permission to use their cases, and for the help they have given me.

Particularly I would like to express my gratitude to Mr. D. McGavin for his personal encouragement and help.

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PROFESSOR G. GREY TURNER AT THE POST-GRADUATE MEDICAL SCHOOL

IN the January number of the BRITISH JOURNAL OF SURGERY for 1937 a visit to Professor Grey Turner at the British Post-graduate Medical School was described. In the ten years' interval much has happened in the world of medical organization and education. There has probably never been a time when all classes of the community have been more interested in the numerous problems which can be summed up in the words " National Health ".

It is at such a moment that in the fullness of time Professor G. Grey Turner, the first occupant, has retired from the professorial chair in surgery at the Post-graduate School in the University of London.

It is an appropriate time for a younger man to undertake the arduous duties, and, fortunately for him, he will have the experience of his predecessor to draw upom.

The war years will have prevented the fulfilment of many cherished schemes ; for which lack of staff, difficulties of replacement, and many other things have presented unsurmountable difficulties.

The " Goodenough " report rightly stresses the two broad necessities for post-graduate medical education, viz. : (1) Facilities for post-graduate medical education and experience for those wishing to become " Specialists " ; (2) Other forms of post-graduate education, including refresher courses for general practitioners.

The latter can probably be best obtained at what will in future be District General Hospitals, whereas the former would be best catered for at a post-graduate medical college in London or similar institution in the provinces associated with the University regional headquarters. These may be necessary in addition to the undergraduate schools as there is an inherent difficulty in mixing under-graduate and post-graduate education.

London, with its twelve scattered undergraduate medical schools, is, however, fortunate in that with adequate planning its post-graduate education can be centralized, if only the will to do this is present.

For those wishing to become specialists in medicine, surgery, or obstetrics and gynæcology the layout is already in existence with the facilities provided in the basic subjects at the Royal College of Surgeons, together with the clinical material and teaching at the Post-graduate Medical School, and the specialist hospitals and institutes. The liason between them, however, must become much closer than it is at present. The post-graduate teaching centre should not cater for any particular post-graduate examination ; that is not its function. Facilities already exist at the various medical schools and institutes. The post-graduate centre should fulfil its true function of disseminating in a general way the knowledge already attained, and organize further endeavours to extend that range by appro-priate research at properly selected centres.

It is to be hoped that a British Academy of Medicine will be erected on the Lincoln's Inn site so that post-graduate teaching for the whole country can be co-ordinated from a proper central authority. To quote from the Goodenough Report :—

" For the avoidance of chaotic development, it is to be hoped that the Universities, in consultation with the pro-fessional and scientific bodies concerned will agree on a national plan for these Institutes and relate their individual schemes to this plan." (Goodenough Report, p. 217.)

A post-graduate hospital should be complete in all departments with a staff sufficient in knowledge and number, so that no patient whatever the disease should have to be sent elsewhere.

The specialist trainee would then be able to realize the relationship of his specialty to general medicine and surgery before passing on to one of the ' special ' hospitals or institutions as a ' finishing ' school. A sufficient number of post-graduate centres and institutions will be required. Until such time as they are available, the District General Hospital could be used for ' resident ' experience provided the staff is adequate in number and teaching experience.

This was fully recognized by the Goodenough Committee who reported concerning post-graduate education.

" Many of its medical institutions have a world-wide reputation, yet London has failed to attract as many post-graduate medical students, even from the BritishCommonwealth, as have centres on the Continent of Europe or in the United States of America. . . . The main cause, as Sir William Osler pointed out as long ago as 1911, has been lack of organization and cohesion. . . . We recommend that when the present war is over these efforts should be pursued with increased vigour and determination."

The report found that the obvious nucleus of a scheme for the post-graduate medical education in London was the British Post-graduate Medical School.

Lord Addison, when Minister of Health, initiated the first steps which led to the foundation of the Post-graduate Medical College. In 1921 a Committee was set up under the Chairmanship of Lord Athlone to prepare various schemes, which later were examined and reported upon by another Committee over which Mr. Neville Chamberlain presided. The constitution and organization of the college was completed by another Committee, of which Lord Chelmsford was the Chairman, and included representatives of the University of London, the Royal Medical Colleges, the Medical Research Council, the Ministry of Health, and the London County Council.

" The aim was to provide such a centre for the advancement of medical knowledge as would be worthy of the British Commonwealth and Empire ", and under the Charter the administration had " to arrange for co-ordination with other authorities at present providing post-graduate or other medical or scientific education in London."

Owing to the war the school has not developed organized departments in the various special subjects and only recently has begun to establish links with the large special hospitals in London on the lines proposed by the Athlone Committee.

It is recognized that this may be due to two main causes ; the geographical isolation of the Hammersmith Hospital on the one hand, and on the other by the fear that special hospitals might lose their identity and freedom of development by such a liaison.

The Goodenough Report gives a series of suggestions (pp. 226–31) whereby the post-graduate teaching for London can be developed. They should be carefully studied by all, as the principles apply to the whole country.

Since the report was written the development of teaching, lectures, and demonstrations organized by the Royal College of Surgeons has been very great and will be expanded still further. The establishment of a British Academy of Medicine would provide the central authority which should organize

Professor G. GREY TURNER

and mould the post-graduate teaching throughout the country. It should also be the body to provide the hallmark for *entrance* into medicine, just as other authorities do, in other professions, e.g., The Inns of Court, Institute of British Architects, etc.

The Minister of Health is taking steps in accordance with the recommendations in Chapter XIX of the Goodenough Report to organize the post-graduate medical education in London, by the formation of a British Post-graduate Medical Federation. A petition for a Royal Charter of Incorporation for the Governing Body of such a Federation will be presented shortly.

" The British Post-graduate Medical School incorporated by Royal Charter in 1931 is an Independent body recognized as a Medical School by the University of London."

It was opened in 1935. The main work of the Department of Surgery is arranged around the

clinical opportunities provided by the Hammersmith Hospital and the Professor has always aimed at establishing continuity in the teaching, which he endeavoured to maintain from the appearance of the patient in the out-patient department, through the wards and operating theatres, to the follow-up clinic. The students do not actually assist with or do operations.

It was a happy choice when Professor G. Grey Turner was invited to be the first occupant of the Professorial Chair of Surgery in the school and to

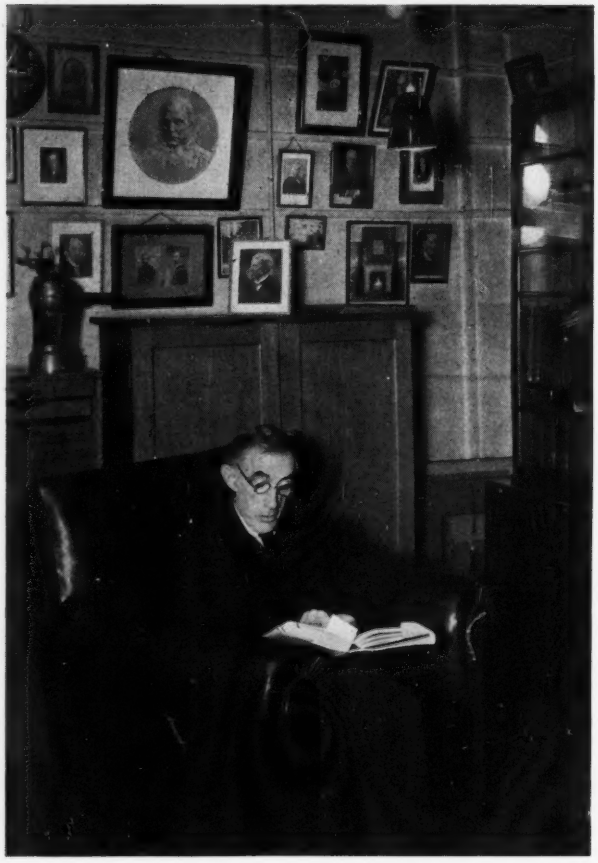

FIG. 515.—Professor Grey Turner in his study.

direct the Department of Surgery. He came to the school with a great record as a man, a surgeon, and research worker, from his own medical school at Newcastle-upon-Tyne, where at the time of his appointment he was Professor of Surgery in the University of Durham and Senior Honorary Surgeon to the Royal Victoria Infirmary.

The appended list of his publications bear witness to his capacity for work during a surgical career of forty-eight years. This list shows only one aspect of his busy life. In the background there are hundreds of medical students, many now getting on in years, who have benefited by his teaching and example both as undergraduates and post-graduates. In addition, throughout this country, the Dominions, and Dependencies of the Crown, and in other countries in Europe, America, and elsewhere there are many surgeons who have been fortunate enough to have been his resident house surgeons or clinical assistants or registrars.

Others have profited by discussing their difficulties with him, reading his contributions to the surgical literature of the world, and by his succinct remarks at discussions during various surgical conferences all over the globe.

Those who served with him during the war of 1914–18 will bear witness to the stimulating effect he had on them by his teaching and endeavours, especially during the anxious periods of "waiting for something to happen" which is so trying to the military surgeon.

He gave of his very best in assisting at the foundation of the BRITISH JOURNAL OF SURGERY, the Association of Surgeons of Great Britain and Ireland, and the International Society of Surgery. He has not only maintained but enhanced the traditions of all. He has been a member of the Council of the Royal College of Surgeons for twenty years. He was one of the Hunterian Professors in 1928, delivered the Bradshaw Lecture in 1935, and the Hunterian Oration in 1945. The Professor throughout his career has been a surgical pilgrim and has visited most of the important clinics throughout the world. One of the great griefs of his life has been the destruction of part of the College and especially the museum and many specimens to which he has devoted so much of his time, by enemy action on May 10, 1941. His Hunterian Oration on "The Hunterian Museum Yesterday and To-morrow" reflected his feelings. It is now published and will be a worthy and standard record for many years to come of the foundation and development of that famous museum in the tradition of John Hunter.

The Department of Surgery has 175 beds, under the direction of the Professor. His staff consists of a Chief Assistant and five First Assistants. These are qualified and trained surgeons, each devoting himself to some special branch of surgery, in addition to general surgery. In other words, they can be described as general surgeons each with a surgical hobby.

In this way they are experts in the department, trained, qualified, and able to deal with the surgery of genito-urinary, thoracic, plastic, neurosurgical, orthopædic, and traumatic cases. No particular branch of surgery is cultivated to the exclusion of others.

The professor is thus able to keep in touch with all these clinics, at the same time following his own particular inclination, which in the case of Professor Grey Turner is abdominal surgery, but not to the exclusion of general surgery, as for many years he has been interested in transplantation of the ureters, the surgery of the œsophagus, and the operative treatment of malignant disease in all its forms.

In normal times it is planned to have twelve house surgeons appointed for six months in a junior post, and six months in a senior one. The appointments will be staggered to procure continuity of service.

The layout of the department is such that wards, theatres, teaching museum, laboratories, and lecture rooms are in close proximity. In this way illustrative specimens can be easily procured for the discussions in the wards or theatres, or a lantern-slide

demonstration can be staged bearing on the work in progress, whether in the ward or theatre.

There is the closest possible liaison between the Otorhinolaryngological and Ophthalmic Departments with that of the surgeon, and needless to say the expert pathologists, biochemists, and radiologists are always available.

A time-table is published each week detailing the various activities proposed for the department. They consist of ward rounds, surgical discussions, operations, and out-patient clinics for general and special cases. There are demonstrations in surgical anatomy and radiology each week and smaller classes in the special branches are always in progress. There is no need for any student to find he has time on his hands, as there is a well-equipped library and school museum, and he can get food at ' the mess ' on the premises.

Each week there is a clinico-pathological demonstration, at which the work of the previous weeks is reviewed, discussed, and correlated with the pathological findings. The specimens, both operative and from autopsy, are available, with pathological experts to discuss and demonstrate them. Everyone is encouraged to take part. From time to time acknowledged experts in some particular branch of surgery are invited to give lectures, and these are all well attended by students working in the different departments.

The students are actually allotted cases in the wards and they present these cases at the ward clinics. The Professor and his assistants give lectures on their own specialty. Clinical talks after the principal ward round are considered most useful and instructive. They are held in a demonstration room near the wards and in close proximity to the museum, and last about one hour.

FIG. 516.—The weekly clinico-pathological demonstration.

During the war, at the request of the Deans of the respective medical schools in London, educational facilities were provided for undergraduates, and at the same time the London County Council provided residential accommodation for a number of them.

A new type of post-graduate student was also accepted, namely, refugees from Nazi oppression.

Intensive " war courses " were also arranged, acknowledged experts giving the lectures and practical demonstrations. The subjects were various, including war surgery of the abdomen, the extremities, the chest, the nervous system, and the miscellaneous aspects of war surgery. There was also an intensive course lasting a week on some one particular subject.

The school was opened in 1935, and, naturally, the peak year for numbers was 1938–9, the students

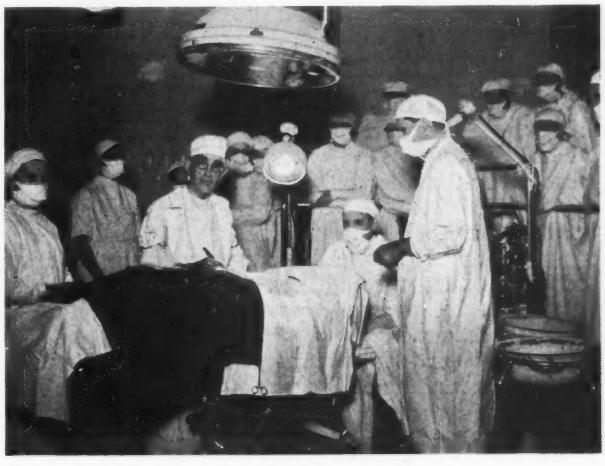

FIG. 517.—An operation in progress.

being two or even three times more numerous in some departments than in 1935. Even during the war period the school was never without students and often from overseas and war areas.

As the war progressed the number of post-graduates diminished. In 1940–41, the last year for which figures were published, 397 students attended from Great Britain and Northern Ireland, 116 from the Dominions, Crown Colonies, and Dependencies, 27 from other countries. In addition there were always visitors from the Allied armies, and from occupied countries.

A typical day's work recently witnessed in the surgical department was as follows :—

It was an operating morning and the Professor explained that every such occasion was only useful if the visitor knew the circumstances of each case and what it was proposed to do. Each important step could then be followed. When students were few they were allowed to come quite close up to the table but on account of the numbers a stand was now used which could be moved so that for each case the most favourable position could be chosen. Further, students deemed most likely to profit were often invited to come down to the Professor's elbow in order that some step might be the more accurately demonstrated.

Operations.—

1. Cholecystectomy for Cholecystitis and Gall-stones in; a Woman aged 80 years.

She had had three severe attacks of pain accompanied by transient jaundice since Easter, 1946, and wished for relief.

Before the operation the history and possible differential diagnosis of the case was discussed,

although the case had been previously demonstrated on a ward round. The bearing of the age of the patient on the problem was discussed.

The lower thorax of the patient, after she had been anæsthetized, was raised by insertion of the double wooden wedge which is so dear to the heart of the Professor, and the arms were extended on a board at right angles from the trunk to prevent any pressure neuritis.

The students were reminded that it was Mayo Robson, of Leeds, who first demonstrated the value of the elevated loin position.

Kocher's incision was used. There were no stones in the common duct and no lesion of the pancreas, so cholecystectomy was done.

During this operation, and the two subsequent ones, the Professor kept up a running commentary, which, if duly noted and memorized, was alone worth much to the onlookers.

"When the gall-bladder enlarges it is usually in the direction of the umbilicus."

"A line from the left anterior superior iliac spine continued through the umbilicus to the right costal margin gives the postion of the fundus of the gall-bladder."

"A gall-bladder swelling becomes more defined as the surrounding inflammation subsides; this is a point to be remembered."

"Kocher—dear old Kocher of Berne—always insisted that this incision disturbed the peritoneal cavity less than any other. I am sure that he was right, and this compensates for its limitations."

"No ! catch it again ! all hæmorrhage must be stopped and prevented. Extravasated blood is dying and dead tissue is an excellent nidus for organisms ! "

"A history and diagnosis of cholecystitis may be the result of early malignant disease of the gall-bladder and that condition is rarely cured by surgery."

"In Great Britain cholecystitis usually means gall-stones, but not by any manner of means is that the case in the Middle and Far East."

"The gall-bladder and its surroundings must be explored slowly and gently, otherwise a fistula into the alimentary canal may be precipitated."

"The way to avoid accidents to the common duct is to dissect so that it is clearly seen, together with the junction to the cystic duct."

"Always ligate and divide the cystic artery before the cystic duct, as the latter can be used for gentle retraction, whereas the most gentle pull on the artery would tear it."

Between the Professor and his assistant, however, there was the silence of perfect understanding.

After the operation the professor closed the wound while the assistant demonstrated the specimen to the onlookers. The professor insisted on the importance of such examination while the abdomen was still open. Even in the most careful hands he had seen a piece cut out of the common duct.

2. Transplantation of the Ureters into the Colon.

This was a preliminary operation before dealing with an extensive malignant growth of the urethra which had extended up into the bladder in a big, stout woman of 63 years. Later it was proposed to do a total excision of the bladder and urethra. (This was successfully carried out a few weeks later.)

The same type of running commentary was kept up. The operation is one which Professor Grey Turner has made peculiarly his own and has described so many times in various papers and discussion. He recently gave a demonstration of many of his early cases before the British Association of Urological Surgeons. He mentioned to the onlookers the first case in which he had transplanted the ureters 34 years ago. Twenty-three years after transplantation he removed a calculus from one of the ureters. This patient is still alive and well, she is the mother of three children and now has two grandchildren. The Professor went on to describe several other cases, contrasting the misery of the incontinent with the contentment after successful transplantation. He also drew attention to the widening field of usefulness for the operation.

He demonstrated every step, mentioning how he differed in small details from the methods of Stiles, Coffey, Henry Wade, and others, and why he considered the technique he now employed gave the best results.

The technique and care exercised were beyond criticism.

Afterwards the details were again discussed with the aid of large diagrams brought into the theatre.

The students then accompanied him into a small lecture room next to the Museum and opposite the Theatre. He gave them half an hour's talk on the surgery of malignant disease, illustrated by specimens, and lantern slides showing Sir Henry Butlin, George Crile, William Stewart Halsted, and others. He considers that the history of surgery should go hand-in-hand with consideration of the art. He showed them the statistical results of operation for cancer of the breast published by Sir Gordon Gordon-Taylor in the *British Medical Journal*, Nov. 26, 1938, which he stated were probably as good as any surgery has ever attained.

A short ward round was then made to see some of the cases recently operated upon. The after-treatment was discussed in a few and reasons for the various methods adopted.

3. Removal of Malignant Glands of the Neck following Epithelioma of the Ear in a man aged 71.

The method of Crile was employed. Reasons for the surgical removal of lymphatic glands in certain cases rather than relying on radiotherapy were given, and it was pointed out that it was Henry Butlin, of Bart.'s, who enunciated the principles on which Crile's method was based.

The operation progressed all the time he was making his remarks. It was done with scrupulous care as only a master of his art could command, and yet all went so smoothly that it simulated the abandon of an accomplished ballerina. The problems, beyond the technical details of the operation, were indicated and discussed as subjects full of interest and importance.

The Professor stressed the point that useful research was always that which arose directly out of clinical work. The accomplishment of his medical colleagues along these lines was mentioned with enthusiasm.

The whole day was an exhibition of a master sure of himself and yet careful in every detail; no better illustration could have been given of the Hippocratic precept:—

> "Wherever the art of medicine is loved, there also is love of humanity."

Professor Grey Turner's personality, which has influenced those who have worked with him so much, cannot be better described than in the words used by Kipling with reference to such another:—

> "Clean, simple, valiant, well beloved,
> Flawless in faith and flame,
> Whom neither ease nor honours moved
> An hair's-breadth from his aim."

His work at the Post-graduate School has initiated a tradition which is of such a standard that those who follow him will do well to maintain.

SOME OF THE PUBLISHED PAPERS OF PROFESSOR G. GREY TURNER

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THE PARASYMPATHETIC SUPPLY OF THE DISTAL COLON

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A PARASYMPATHETIC supply arising from the sacral nerves to the distal colon has long been the subject of controversy. Such a supply had been assumed on physiological grounds, although there was no topographical evidence until Telford and Stopford, in 1934, described the anatomical distribution of the parasympathetic fibres. While there is general agreement as to the origin and distribution of the sympathetic supply, there is no exact knowledge regarding the parasympathetic innervation, and it is necessary to establish first that there is such a supply and precisely how it reaches the bowel.

The general pattern of the nerve-supply of the alimentary canal consists of extrinsic nerves, such as the vagus, entering the bowel wall and coming into intimate synaptic connexion with the intrinsic cells of the colonic plexuses (Auerbach's and Meissner's). These colonic plexuses consist of an interlacing of fine fibres and ganglia throughout the whole bowel. Stimulation of any one part of these plexuses will thus spread in a wave-like movement up and down the length of the bowel.

Dogiel (1896), as quoted by Babkin (1944), was the first to establish that there are two main types of ganglion cells, Type I and Type II, in the enteric plexuses. The relative numbers of cells of each type vary in the gastro-intestinal tract of the dog. By cutting the vagus and pelvic autonomic and allowing them to degenerate, Lawrentjew (1926), quoted by Babkin (1944), established that the cells of Type I in the proximal and middle portions of the gastro-intestinal canal are in synaptic connexion with the vagus and those in the hinder part of the the canal with the pelvic autonomic. In the rectum, again, the extrinsic nerve-fibres derived from the pelvic autonomic are more numerous. Where the parasympathetic fibres predominate there is a correspondingly greater number of Type I cells.

Schmidt (1932), in a series of histological investigations in which the vagus was sectioned just below the diaphragm, found degenerated fibres in the ascending and transverse colon. They were less numerous in the latter than in the former, while no evidence of nerve degeneration was found in the distal colon. Division of the sacral nerves showed degeneration of nerve-fibres throughout the whole of the large gut; this degeneration predominated in the hind-gut area.

If, therefore, a parasympathetic supply to the whole of the large bowel exists, its distribution should be established. From a survey of existing anatomical and physiological literature two alternative possibilities were considered:—

1. That the distal distribution of the cranial parasympathetic extends as far as the lower limit of the colon and that the sole contribution of the sacral parasympathetic is to the rectum.

2. That the areas of vagus and sacral parasympathetic join or overlap at some position which would correspond to the morphological meeting of hind- and mid-gut. In other words, that the innervation of the entire hind-gut is from the sacral parasympathetic.

From the point of view of surgery of the distal colon and pelvic viscera, it is essential to establish which of these two hypotheses is correct—namely, the distal colonic extent of the vagus and the proximal extent of the sacral parasympathetic.

A junction in the parasympathetic innervation of the large bowel was first suggested by Cannon (1902) when he found a ring of contraction dividing the colon into two portions. Arendt (1945), in a radiological study, was unable to find any anatomical sphincter in this neighbourhood, but from his radiological observations he suggested that this contraction ring was a pivoting point in a change of colonic innervation between the cranial and pelvic parasympathetics. The situation of this point was variable in the transverse colon, but had a tendency to be in the right third. "An antagonism between

the two spheres of influence must occur, either the distal part has to be wide and relaxed and the proximal part contracted, or the reverse must be the case. The phenomenon of the contraction ring permits an explanation of a critical reaction at the point of overlapping of nerve impulses". Arendt suggested that this point be called the Cannon-Boehm point in honour of these earlier observers.*

It was assumed for a long time that the vagus was the sole parasympathetic supply to the colon; indeed, the lower region of the rectum, which obtained its innervation from the nervi erigentes, was the only part of the gut excluded from this vagal influence. Jayle and Cabanac (1932) have actually described vagal fibres to the distal colon; but this is not generally accepted. Like Mitchell (1935), we also found it impossible to dissect vagal fibres extending to the distal colon owing to the marked complexity in this area.

Woollard (1935) was inclined to follow the French anatomists who extend the vagus anatomically as far as the limits of the colon and confine the pelvic nerve to the pelvis. However, in his illustration there is a suggestion that there is a supply to the colon coming upwards out of the pelvis from the sacral autonomic. Savich and Soshestvensky (1917) demonstrated that stimulation of the vagus in the cat, in which the spinal cord had been cut below the medulla, was only effective as far as the ileocæcal valve.

McCrea (1924), in an investigation of the abdominal distribution of the vagus, showed that the anterior vagal plexus supplied twigs to the pyloric antrum on both anterior and posterior surfaces. In no case did it send fibres as far as the pyloric canal or sphincter. Fibres were also given off this plexus to the cœliac plexus. The posterior vagal trunk supplied fibres to both right and left cœliac ganglia, while other fibres anastomosed with the sympathetic fibres and ran with the superior mesenteric artery. He stated that "it is a matter of considerable difficulty to determine whether these last fibres are vagal or sympathetic or both, on account of their intricacy and the manner in which the nerves are matted together". These findings of McCrea were confirmed by Brandt (1920), and it appeared that the majority of vagal fibres were destined for the stomach and that very few fibres carried on to the cœliac plexus.

It would thus appear that the vagus is limited to some point in the transverse colon at the most. We therefore tried to find anatomical evidence of a pelvic parasympathetic innervation extending upwards as far proximal as this point.

PREVIOUS ANATOMICAL OBSERVATIONS

Telford and Stopford (1934) described on the ventral side of the inferior hypogastric plexus two small nerve-bundles which could be traced upwards. These bundles converged to meet and fuse at the left side of the hypogastric plexus, and, passing upwards, crossed the left common iliac artery to join the inferior mesenteric artery one to one and a half inches distal to the origin of that artery from the aorta. The fibres from the single bundle were distributed with the branches of the inferior mesenteric artery. Where it crossed the left common iliac artery fibres were given off to run with the sigmoid and superior hæmorrhoidal vessels. These workers further claimed that, by careful dissection, they were able to follow the fibres downwards through the inferior hypogastric plexus and to demonstrate their continuity with the pelvic splanchnic nerves.

Mitchell (1935), in a careful investigation on 15 European infant bodies, found this arrangement in 4 out of the 15 bodies only; but in 10 others he found colonic nerves which he decided were probably important parasympathetic pathways to the colon. These colonic nerves arose from the inner borders of the hypogastric nerves and the upper part of the hypogastric plexus and passed direct to the sigmoid colon. There was no proof of the assumption that these were parasympathetic colonic fibres, because, as he states, it was "impossible in these small subjects to trace the course of these fibres in the inferior hypogastric plexus."

The description of Telford and Stopford entails important surgical implications and is widely accepted. But as Mitchell's observations differed so considerably from their description, the object of our dissections was to ascertain the anatomical distribution of the parasympathetic fibres to the distal colon in the South African Bantu.

AUTHORS' INVESTIGATIONS

Method and Materials.—Nine infant bodies, including two seven-month fœtal bodies, and nine adult bodies, all Bantu, were dissected. The following technique for the exposure of the parasympathetic supply to the distal colon was adopted:—

1. The anterolateral abdominal wall was completely removed.

2. The symphysis pubis was split longitudinally and forcibly opened.

3. In order to obtain a flat plane, so that the posterior aspect of the rectum and the anterior aspect of the sacrum could be approached with ease, the whole side wall of the pelvis was sawn off, leaving a small portion of the ilium attached at the sacro-iliac joints. Care was taken not to injure the pelvic colon or the soft tissues over which the inferior hypogastric nerves ran.

4. The bladder was removed in all bodies; the uterus and vagina were removed in female bodies and the prostate in adult male bodies. This technique facilitated approach to (*a*) the emergence of the sacral nerves; (*b*) the origin of the sacral parasympathetic; (*c*) the entire rectum.

General Survey of Findings from Dissections.—Variations occurred in practically every body and even between the right and left sides of the same body. Our results are best summarized, therefore, by giving a general survey of the origin, course, and distribution of these parasympathetic fibres.

1. *Left Side* (*see Figs.* 518–520).—The interlacing pelvic autonomic plexus usually arises from the

* On examination of 26 adult cadavers, we found that in 22 the descending colon was contracted, while the ascending and part of the transverse colon was dilated. In 6 of these 22 cadavers there was a definite contraction ring in the distal half of the transverse colon.

anterior aspect of second and third sacral nerves within a centimetre of the exit of these nerves from the anterior sacral foramina. Well-defined fibres proceed anteriorly, and these are the classical nervi erigentes. In addition to these, moderately thick strands, usually from 3 to 6 in number, pass medially from the plexus, upwards and anteriorly, and could be traced to the distal colon.

FIG. 518.—Adult body. Origin, course, and distribution of pelvic parasympathetic colonic fibres from sacral nerves. The specimen is being viewed by an observer standing on the left side. The bowel has been displaced to the right, the pelvic wall on the left side has been removed. 1, Dense parietal pelvic fascia being pierced by some of these fibres. 2, Rectum. 3, Sacral somatic nerves giving rise to the nervi erigentes and parasympathetic nerves. 4, Superior hæmorrhoidal artery. The association of this artery and the parasympathetic fibres is seen. The uppermost fibre is at least 2 in. from the origin of the inferior mesenteric. The lowermost fibres would be absolutely safe in a periarterial strip of the inferior mesenteric. 5, Sacral sympathetic ganglion. 6, Left inferior hypogastric plexus, the lower end of which can be seen running into the parietal fascia.

In all illustrations the parasympathetic fibres have been painted over in white to differentiate them from the other structures.

A feature of each dissection is a striking rich whiteness of these parasympathetic colonic nerves, which is especially evident in the infant bodies. The fibres also give the impression of having minute undulations on their anterior surface, while on some of the fibres an extremely delicate blood-vessel may be seen. The appearance of a red vessel running on a creamy-white nerve is an excellent aid in tracing these nerves up and down, from the midst of the inferior hypogastric plexus. One of our main technical difficulties was to trace these fibres through the dense felted parietal layer of pelvic fascia, especially in the adult bodies; eight were discounted because of failure to trace the continuity of the fine nerves through this fascial layer.

Shortly after piercing the parietal layer of pelvic fascia fibres are given off to the rectum, while the remainder become closely associated with the superior hæmorrhoidal artery. The fibres on the left on their upward course show connexions with the inferior hypogastric plexus. At about the level of the sacral promontory the fibres swing away from the artery across the left common iliac artery, and, passing upwards, run into the mesentery of the bowel. It is noteworthy, as Mitchell likewise found, that

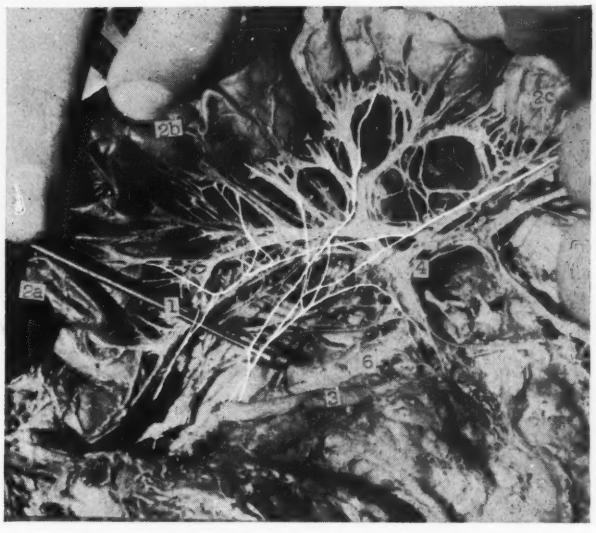

FIG. 519.—Infant body. Course and distribution of the left pelvic parasympathetic colonic fibres. The body is viewed by an observer standing on the left side and the rectum, pelvic colon and descending colon have been displaced to the right. The left side of the body is undermost in the photograph. The sacral nerves are not visible in this photograph; however, the pelvic parasympathetic colonic fibres were found arising from them. 1, Pointer raising these fibres from the anterior aspect of the sacrum. The fibres nearest the tip of the pointer are in close proximity to the inferior hypogastric plexus which is lying deep to them. Connexions between these can sometimes be seen. The fibres farther from the tip of the pointer can be seen accompanying the superior hæmorrhoidal artery. 2, (*a*) Rectum, (*b*) Pelvic colon, (*c*) Descending colon. 3, Ureter. 4, Inferior mesenteric artery at the point of origin of the left colic artery. Immediately above is seen one of the sigmoid arteries. The parasympathetic fibres can be seen crossing the vessels. 5, Superior hæmorrhoidal artery. 6, Left common iliac artery.

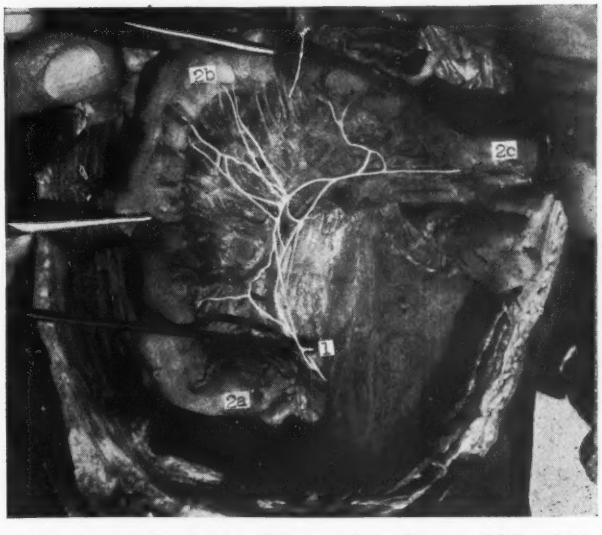

FIG. 520.—Infant body. Course and distribution of left colonic parasympathetic fibres. The body is lying on its back and is viewed from the front. The cut edges of the abdominal wall can be seen. The pelvic and descending colon have been displaced to the right. In this specimen the sacral origin of the fibres was not dissected. 1, Tip of the pointer lifting these fibres from the superior hæmorrhoidal artery. This close association with the superior hæmorrhoidal artery in the early part of their course is always a prominent feature. Consequently, in resection of the rectum, these fibres will necessarily be removed. 2, (*a*) Rectum, (*b*) Pelvic colon, (*c*) Descending colon, all of which have been displaced to right side to show the nerves running in the mesocolon.

these colonic fibres do not follow the arterial branches which are being distributed to the bowel wall; they cross them obliquely on the left (*Fig.* 521).*

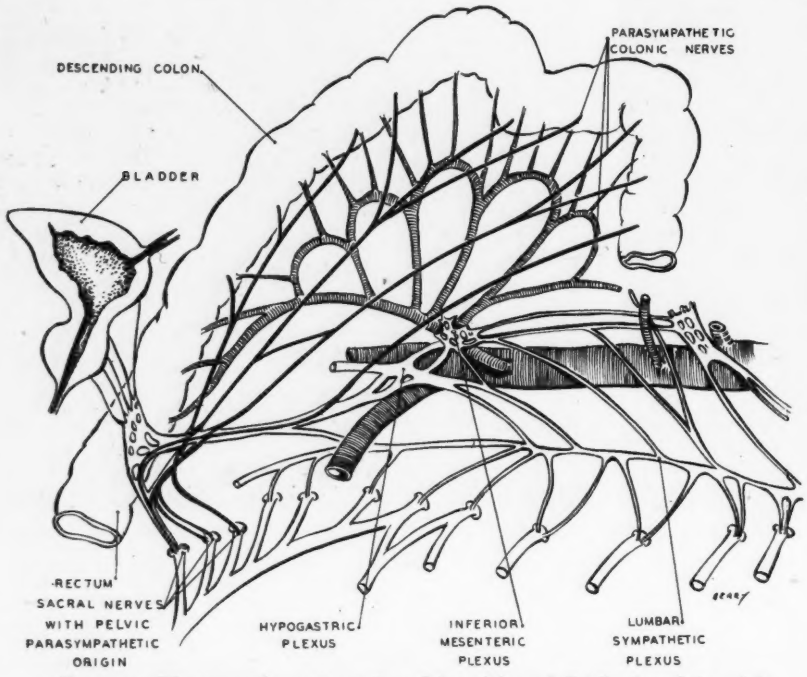

FIG. 521.—Diagrammatic representation of the origin and distribution of the pelvic parasympathetic colonic nerves. The lower descending and pelvic colons have been swung over to the right. (*Modified from Trumble.*)

From the main upward stream fibres are given off at intervals, passing anteriorly, and have been traced definitely into the bowel wall. Macroscopically, the highest point to which these fibres are generally distributed is the middle of the descending colon; smaller fibres can, however, be seen to become associated with the ascending branches of the colic artery.

2. *Right Side* (*Figs.* 522–524).—The general plan is similar to that of the left, but on the whole the nerves lie at a distance from the superior hæmorrhoidal artery and in closer association with the inferior hypogastric plexus. In one instance the colonic nerves run on the surface of the inferior hypogastric plexus and leave just below the bifurcation of the superior hypogastric plexus (presacral nerve) to become associated with the inferior mesenteric artery, at about the point indicated by Telford and Stopford, i.e., 1–1½ in. from the origin of the artery. The fibres which lie on the right side of the colonic mesentery in the majority of cases reach a higher level of the colon than those on the left. In addition, fibres are given off to the iliac vessels and to the ureter. There was no demonstrable connexion between the nerves of the right and left sides.

Reviewing the position, it will be seen that our findings contrast markedly with those of previous workers. We cannot establish the simplicity of arrangement described by Telford and Stopford; nor can we find that these nerves have the degree of compactness and close association with the inferior hypogastric plexus they claim. We find Telford and Stopford's description applicable in only one out of eighteen dissections; and yet in this single instance fibres arose from the left pelvic splanchnics, which were quite unassociated with this artery. As already noted, in no cases did we find the colonic nerves being distributed with the arterial supply, nor was there any macroscopical connexion between the right and left sides, these being two main points in Telford and Stopford's description (*Fig.* 525).

There is considerable similarity between the colonic fibres which Mitchell describes in the European and those we find in the Bantu; Mitchell also found that these nerves do not follow the course of any particular vessel. However, in contradistinction to Mitchell's observations, we do not find that these nerves arise from the sympathetic fibres, i.e., the hypogastric nerve and the inferior hypogastric plexus, but directly from the sacral nerves themselves. There are connexions between these nerves arising from the sacral nerves and these plexuses; but in the Bantu, the pelvic

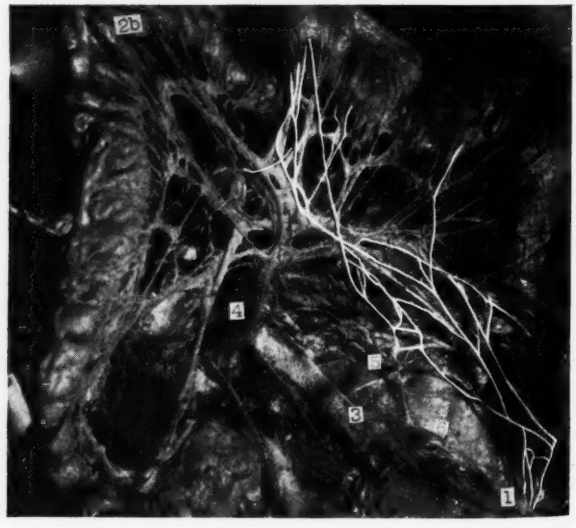

FIG. 522.—Infant body, right side of *Fig.* 519. Origin, course, and distribution of the right pelvic parasympathetic colonic fibres. The body is viewed by an observer standing on the right side. The bowel has been displaced to the left, which is in the uppermost part of the picture, i.e., the body is lying on its right side. 1, Point of origin of right parasympathetic fibres from sacral nerves. The fibres can be seen passing to the left and do not have in the early part of their course such close association with the superior hæmorrhoidal artery as on the left side. 2, (*a*) Rectum, (*b*) Descending colon, which has been swung over to the right, (*c*) Sigmoid colon. 3, Right common iliac artery. 4, Inferior mesenteric artery. The fibres are quite unassociated with this artery, and stripping of this structure would not affect them. 5, Inferior hypogastric plexus. The lower pelvic parasympathetic colonic fibres can be seen crossing this structure. 6, Sacral sympathetic ganglion.

* In an undissected body these fibres would be lying against the posterior abdominal wall, being separated from it by the left layer of parietal pelvic mesocolon, the resection of which will clearly expose these nerves.

parasympathetic and sympathetic exist as distinct entities. This seeming anatomical discrepancy between the European and the Bantu may be due merely to the different dissecting techniques adopted by ourselves and Mitchell. We obtained direct access to the anterior aspect of the sacrum and commenced the dissection from the point of origin of these fibres.

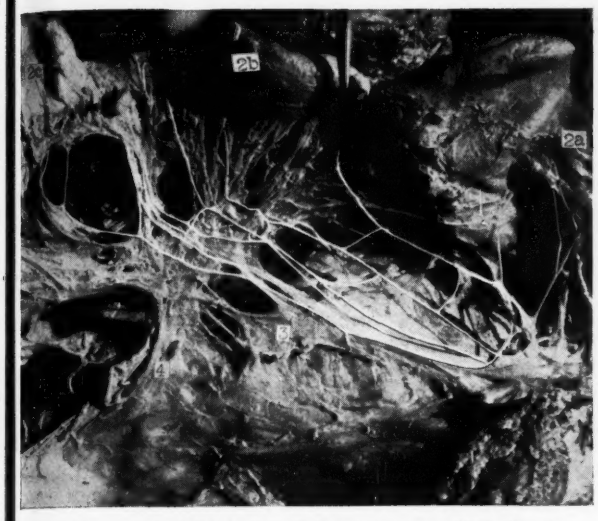

FIG. 523.—Adult body. Origin, course, and distribution of right pelvic parasympathetic colonic fibres. The body is being viewed by an observer standing on the right side. The left side is above in the photograph, to which side the bowel is displaced. 1, Sacral nerves with colonic parasympathetic fibres and the nervi erigentes arising from them. 2, (*a*) Rectum, (*b*) Pelvic colon, (*c*) Descending colon, which has been swung over to the right. 3, Inferior hypogastric plexus running downwards. On the surface of the structure can be seen the parasympathetic fibres. These fibres are individual, having no degree of compactness. 4, Inferior mesenteric artery. Above this artery, i.e., to the left, the parasympathetic fibres can be seen running in the mesocolon crossing the blood-vessels.

DISCUSSION

In the Bantu there is gross anatomical evidence that nerve-fibres arise from the second and third sacral nerves and are distributed directly to the descending colon and rectum. These nerves send communicating branches to the hypogastric plexus, but do not in general follow the arterial distribution. To these independent fibres we ascribe a parasympathetic function because of their sacral origin. In support of this thesis there is radiological, physiological, and clinical evidence.

Arendt's radiological evidence of a Cannon-Boehm point, which has been dealt with earlier, is in agreement with our ideas, as are Denny-Brown and Robertson's clinical observations (1935). These investigations concluded that the mechanism which controls the evacuation of the bowel is mediated entirely through the lower parasympathetic sacral segments of the spinal cord and its peripheral plexuses. There is no evidence that the sympathetic system plays any part. From a colon-metrogram study of the change in bowel activity after lesions of the nervous system at various levels, it is clear that reflex activity and ability to empty the colon effectively persist until the reflex centre in the spinal cord, corda equina, or the pelvic nerves has been injured. After sympathetic denervation of the rectum and colon there was no alteration in peristalsis.

This work of Denny-Brown and Robertson has the support of the comparative physiological evidence of Wright, Florey, and Jennings (1938), who found

FIG. 524.—Infant body. Origin, course, and distribution of the right pelvic parasympathetic colonic fibres. The body is being viewed by an observer standing on the right side. The left side is at the top of the photograph, to which side the bowel is displaced. 1, Tip of pointer lifting these fibres off a part of the inferior hypogastric plexus which is descending into the pelvis. Connexion between this plexus and the pelvic parasympathetic fibres can be seen at this point. 2, (*a*) Rectum. (*b*) Pelvic colon, (*c*) Descending colon. 3, Origin of the pelvic parasympathetic colonic fibres from the sacral nerves. 4, Reflected anterior abdominal wall. 5, Right common iliac artery. Immediately below is seen a sacral sympathetic ganglion. 6, Inferior hypogastric plexus. 7, The ureter is displaced to the right. 8, Inferior mesenteric artery.

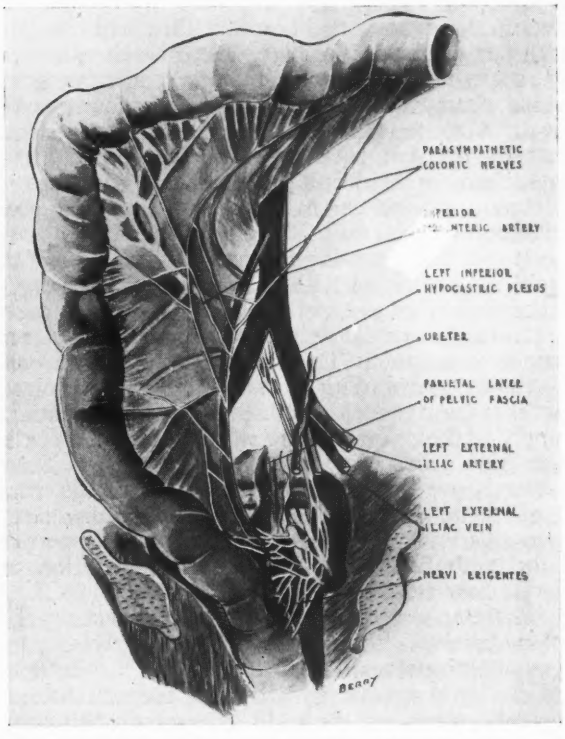

FIG. 525.—A schematic representation of the pelvic parasympathetic colonic nerves showing how they traverse the parietal pelvic fascia and their distribution in the mesocolon. The lower descending and pelvic colons have been swung over to the right.

that stimulation of the colonic sympathetic nerves caused relaxation of the colon, contraction of the blood-vessels, and did not excite any secretion of fluid. Stimulation of the nervi erigentes, on the other hand, caused contraction of the bowel with secretion and vasodilatation. To prove the distribution of the pelvic autonomic nerves to the descending colon they placed a ligature tied tightly round the colon and no matter whether it was placed high up or low down, the site of this ligature determined the upper limit of secretion and contraction following stimulation of the nervi erigentes. Even when scrupulous care was taken to avoid including any mesenteric structures in the ligature, this was the case. In three cats, where the string was tied loosely so that the tunica muscularis was not crushed, the effect of stimulation extended above the ligature as far as the lower three inches of ileum. Stimulation of the sympathetic nerves showed no such delimitation by the ligature, but extended as far as the vessels with which they were associated. This shows that the sacral parasympathetic fibres are not distributed with the vessels or with the sympathetic nerves, but enter the gut in the pelvic part of the colon and the upward distribution of stimuli transmitted through them takes place in the bowel wall.

Lawrentjew (1926), quoted by Babkin (1944), states that each parasympathetic fibre on entering the bowel wall, branches out and synapses with a a great number of ganglion cells in the colonic enteric plexuses. This he calls a "multiplication phenomenon". If this is so, then only a few parasympathetic fibres would be required to transmit impulses to the whole of the lower colon through the colonic plexuses, since, as already established by the presence of Type I cells, they are in synaptic connexion throughout the bowel. This is in keeping with our dissection findings, where we have three to six basic fibres from either side, constituting the whole parasympathetic supply to the lower colon. Again Adamson and Aird (1912) found constantly that by division of the pelvic parasympathetic of cats there was definite radiological evidence of dilatation of the colon after six weeks and gross dilatation at the end of fifteen weeks.

If our interpretation is correct, then some of the problems associated with colonic and pelvic surgery become clarified:—

1. In periarterial stripping of the inferior mesenteric artery, which Telford and Stopford advocate for the treatment of megacolon, they lay stress on the fact that damage may be done to the parasympathetic supply to the colon if this stripping is carried farther than the proximal 1½ in. of the artery. Since, however, we have shown that the colonic parasympathetic supply is fundamentally dissociated from this artery, we feel there can be no parasympathetic dysfunction caused in this operation, no matter how far the artery is stripped.

2. Resection of the rectum and lower pelvic colon involves interruption of these pelvic parasympathetic nerves, since on the left side the fibres are closely associated with the left superior hæmorrhoidal artery; on the right side some of the right parasympathetic sacral fibres will be divided, since they run in the pelvic mesocolon, part of which is removed in a resection of the pelvic colon.

3. High resections of the colon, i.e., proximal to the point of entry of the highest parasympathetic colonic fibre (which on the average is situated at the mid-point of the descending colon), involve a break in continuity of the colonic plexuses at the point of resection. Parasympathetic impulses will, therefore, be prevented from reaching the gut proximal to the resection. Theoretically, this deprivation of parasympathetic stimuli to the proximal colon should result in functional disturbance; whether this obtains clinically has not as yet been demonstrated.

4. Again, in presacral neurectomy, if the findings of Telford and Stopford are correct, there should be fundamental dysfunction of the parasympathetic supply of the rectum and lower colon. There is no reason to suppose that in such fundamental anatomy as this, there would be any comparative racial differences between European and Bantu, and we have shown that the colonic parasympathetic supply does not have the close association with the hypogastric plexuses Telford and Stopford suggest. Thus, even if the presacral nerve and the upper parts of the right and left inferior hypogastric plexus were removed, there would be no vital damage done to the parasympathetic functions of the rectum and lower colon.

CONCLUSIONS

1. The parasympathetic innervation of the distal half of the large bowel is derived from the sacral division of the parasympathetic system.

2. The nerves enter the distal colon independently of the blood-vessels and end in association with the intramural colonic nerve-plexuses.

3. Periarterial stripping of the inferior mesenteric artery and presacral neurectomy should not interfere with the parasympathetic function of any part of the colon.

4. In resection of the rectum and pelvic colon, the parasympathetic supply to the colon will be destroyed.

5. In high resection of the colon, that portion of the colon between the point of resection and the distal point of vagal parasympathetic supply, will be deprived of its parasympathetic supply.

We wish to express our thanks to Professor Raymond A. Dart for allowing us facilities in the Department of Anatomy; and to Mr. A. Lee McGregor for suggesting this investigation.

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A STATISTICAL STUDY OF 1405 CASES OF CANCER OF THE STOMACH

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In its Twenty-first Annual Report, the British Empire Cancer Campaign (1944) published a statistical survey of 1405 cases of primary cancer of the stomach compiled by the Clinical Cancer Research Committee. This report was based on the replies to a special questionnaire which was issued to all the voluntary and municipal hospitals in the Administrative County of London, with the exception of a few special hospitals, and was filled in by the Registrars between April 1, 1938, and Sept. 3, 1939. At the time of publication of the report only a four-year follow-up was possible; now that the whole series has been followed up for five years, with only 1 per cent of the patients untraced, an analysis of the main findings, particularly as regards factors governing operability and survival rate, may be of interest and value to surgeons.

There were 856 males (11·7 per cent of all male cases of cancer registered), and 549 females (6·9 per cent of all female cases), so that the sex ratio is 60·9 ± 1·3 per cent of males, or roughly three males to two females. The region of the stomach affected was known in 871 cases by operation or post-mortem findings and the sex ratios in these cases are shown in *Table I*.

Table I.—Site of Growth

Site of Growth	Number in Site	Percentage	Percentage of Males
Pyloric region	470	54·0	62·1 ± 2·2
Mid-gastric or whole stomach	287	33·0	64·1 ± 2·8
Cardiac region	114	13·0	64·9 ± 4·5
	871	100·0	

The differences in the percentage of males in the different regions are not statistically significant.

Age Distribution (*Table II*).—The youngest cases were a female aged 20 and a male aged 21, both proved microscopically, and a female aged 23, whose subsequent clinical course proved that the condition was malignant, though there was no microscopical examination.

Table II.—Age Distribution

Age Group	Males	Females	Total
15–24	1	2	3
25–34	8	16	24
35–39	27	21	48
40–44	45	16	61
45–49	60	38	98
50–54	117	55	172
55–59	138	78	216
60–64	167	113	280
65–69	143	89	232
70–74	94	72	166
75–79	44	39	83
80 and over	12	10	22

Males		*Females*	
Mean age	60·06 ± 0·36	Mean age	60·67 ± 0·51
Standard deviation	10·70 ± 0·26	Standard deviation	11·90 ± 0·36
Difference of the means	0·61 ± 0·62		

The mean age of the 691 patients who were submitted to operation was 56·83 years. The relationship between age, operability, and results will be examined later.

Aetiology.—The occupations of 856 male patients were arranged in order of frequency and compared with the percentage of males over 14 years of age in Greater London following the same occupations, as recorded in the 1931 Census. The figures corresponded closely enough to warrant the conclusion that the hospital admissions were a fair sample of the occupied population of Greater London. The figure for clerks and typists was significantly lower than expected, but this may be accounted for by the fact that many were shown in the 'retired' group, the previous occupation not being given. The Registrar-General (1938) states that there is no statistical evidence of any connexion between mortality from gastric cancer and the effects of occupation. Investigations into the habits of patients in regard to consumption of alcohol, hasty eating, hot or highly spiced food did not yield any statistically significant results, as the percentage of cases in which the question was not answered was too high and no control figures for the general population were available. Oral sepsis was present in 26 per cent of the patients, the percentage of males being nearly twice that of females. Herbert and Bruske (1936) found that gross oral sepsis was present in 28 per cent of 500 unselected hospital patients, aged 30–60, with the sexes in equal numbers, figures which may be used as a control. 19·6 per cent of the patients gave a history of previous long-continued dyspepsia, in 13·2 per cent of whom there had been a variable period of freedom from symptoms prior to the onset of the present illness and in 6·5 per cent the symptoms had been continuous. Payne (1940) found that in about 20 per cent of 506 cases seen at St. Bartholomew's Hospital the length of history exceeded two years.

First Symptom.—Definite pain after food was the first symptom in 24·7 per cent of all patients and vague dyspeptic symptoms in about 18–22 per cent, whatever the situation of the growth. Those in the pyloric region commenced with pain not definitely related to food in 24 per cent and with vomiting in 14·7 per cent. An insidious onset with asthenia and anorexia was most common (18 per cent) in growths of the mid-gastric region, whilst dysphagia and regurgitation of food were common initial symptoms (26 per cent) of those in the cardiac region. Sudden onset with hæmatemesis occurred in 1·5 per cent and was most frequent in growths of the cardiac region (3·5 per cent). In 0·6 per cent of patients

there were no symptoms directly referable to the stomach and the diagnosis was first made at operation or at post-mortem examination. In 1·3 per cent of patients the discovery of metastases in bones, lungs, or lymph-nodes preceded that of the primary. The onset of symptoms was stated to have been sudden in 22·8 per cent and gradual in 68·4 per cent.

Delay in Seeking Medical Advice.—54·5 per cent of all patients consulted a doctor within the first three months, another 10 per cent within the next three months, leaving 35·5 per cent in whom the disease was presumably of over six months' duration when first seen, but in 22 per cent the exact interval was not stated.

Delay in Sending to Hospital.—16 per cent of the patients came direct to hospital, 37 per cent were referred to hospital for investigation at once and 13 per cent after an interval of less than three months; but 19 per cent were treated symptomatically for more than three months and 1 per cent were told that there was nothing to worry about. In 13·8 per cent the question was not answered. The figures for the 691 operated cases showed no significant differences from the above percentages.

Findings on Examination.—

Weight Loss.—17·5 per cent of the patients had lost up to 2 st. in weight since the onset of symptoms, 19·4 per cent more than 2 st., whilst in 52·5 per cent the exact amount was not known. In only 3·8 per cent had there been no loss of weight.

Palpable Tumour.—There was a definite palpable tumour in 49 per cent of the patients and an indefinite mass in a further 9 per cent.

Clinical Signs of Dilated Stomach.—Obstruction to the passage of food was diagnosed clinically in 33·6 per cent of growths in the pyloric region, 10 per cent of mid-gastric growths, and 7·0 per cent of those at the cardia. An X-ray examination after an opaque meal was carried out in 68·5 per cent of all patients. The findings are shown in *Table III*, by regions affected.

Table III.—X-RAY FINDINGS (Percentages)*

	Pylorus	Mid-gastric	Cardia	Region not Stated
Total number of patients examined	335	187	86	355
Filling defect	68·5	64·2	68·6	81·4
Obstruction	39·1	9·0	30·2	18·3
Ulcer	7·4	13·9	3·5	5·3
Leather-bottle stomach	0·9	7·0	0·0	4·2
Negative findings or condition reported non-malignant	5·1	10·1	11·6	3·1

* As more than one finding may be recorded in a single case, the percentages do not add up to 100.

At subsequent operation the site of the disease was found to have been correctly indicated by X rays in 90 per cent of the pyloric cases, 75·5 per cent of the cardia cases, and in 60 per cent of those in the mid-gastric region.

Test-meal (*Table IV*).—An estimation of the free hydrochloric acid by means of a test-meal was carried out in 33 per cent of all patients.

Gastroscopy.—Gastroscopy (or œsophagoscopy when appropriate) was carried out in 10·4 per cent of all patients, and in 1 to 1·7 per cent of those with growths in the mid-gastric or cardiac regions was the only means by which a definite diagnosis could be made.

Table IV.—EXAMINATION OF TEST-MEAL (Percentages)

	Pylorus	Mid-gastric	Cardia	Region Not Stated
Total number of patients examined	180	92	29	163
Hyperchlorhydria, above 45 c.c. of N/10 HCl	8·8	8·7	0·0	3·0
Normal acidity, 20–45 c.c.	15·0	9·7	10·3	8·0
Hypochlorhydria, below 20 c.c.	12·8	16·3	10·3	12·9
Achlorhydria	63·3	65·2	79·3	76·1

Distant Metastases.—Clinically recognizable distant metastases were present in 32·5 per cent of all patients on admission to hospital. In 6·9 per cent the cervical or supraclavicular lymph-nodes were affected and in 5·4 per cent metastases were palpable on rectal examination. Of 457 recognizable metastases 85·3 per cent were in the liver or abdominal organs, 3·5 per cent in the lungs, and 3·6 per cent in the bones.

Treatment (*Table V*).—The manner in which the 1405 patients were dealt with in hospital is shown in *Table V*.

Table V.—TREATMENT OF 1405 PATIENTS DIAGNOSED AS CANCER OF STOMACH

	Patients	Percentage of Total
No operation or radiotherapy	681	48·4
Radiotherapy	33	2·3
Operation	691	49·2
Exploration only	233	16·6
Palliative procedure	215	15·3
Resection	243	17·3

For comparison with these figures we have the statistics of the Mayo Clinic for the years 1907–38 (Walters, Gray, and Priestley, 1942). This is shown in *Table VI*.

Table VI.—CARCINOMA OF THE STOMACH: GENERAL DATA
(Diagnosis established in 10,890 Cases: 1907 to 1938 inclusive)

	Patients	Percentage of Total (10,890)
No operation	4648	42·7
Operation	6242	57·3
Exploration only	2431	22·3
Palliative procedure	1039	9·5
Resection	2772	25·5

Morley (1937) resected in 28 per cent of 207 cases, and Lahey (1935) in 26 per cent of 195 cases. Walton's (1936) figure of 36 per cent appears to refer to cases operated on and not to the total seen. 26 per cent of all cases diagnosed may be taken as the average resectability rate at present.

Operations and Results (*Table VII*).—The figure for 'operation fatalities' includes all deaths from any cause within one month of an operation, whether radical or palliative.

The five-year survival rate for males for all radical operations was 19·8 per cent and for females 27·1 per cent.

Limitation of space compels the presentation of the figures in a single table, but the tables for the individual regions showed that operation mortality was lowest in growths of the pyloric region.

For comparison we may take the following figures compiled from the published statistics of the Mayo Clinic (Walters et al., 1942), shown here as *Table VIII*. The five-year survival rate for males for all methods of resection was 28·6 per cent and for females 29·8 per cent.

It appears, therefore, that in London 49·2 per cent of all cases seen were submitted to operation and 17·3 per cent were resected, whereas in the Mayo Clinic series the percentages were 57·3 and 25·5 respectively. The operative mortality in London was double that in the Mayo Clinic and the five-year survival rate was 23·1 per cent against 28·9 per cent in the latter. Some of the factors which might account for these differences are examined in the following paragraphs.

Table VII.—Operations and Results

Operation	Number	Operation Fatalities	Survived 5 Years	Died with Cancer	Died without Cancer	Untraced	Operation Mortality Percentage	Survived 5 Years Percentage of Traced Cases
Radical :—								
Total gastrectomy	20	18	—	2	—	—	90·0	—
Subtotal gastrectomy	9	4	—	4	—	1	44·4	—
Partial gastrectomy (Billroth I)	27	8	8	9	1	1	29·6	44·4
Partial gastrectomy (Polya)	181	46	28	97	5	5	25·4	21·5
Partial gastrectomy with removal of part of œsophagus	4	4	—	—	—	—	100·0	—
Local removal of growth	2	—	—	2	—	—	—	—
Total radical operations	243	80	36	114	6	7	32·9	23·1
Palliative and Exploration :—								
Palliative gastrectomy	21	12	1	8	—	—	57·1	11·1
Gastro-enterostomy	136	39	5	90	—	2	28·7	5·3
Gastrostomy or jejunostomy	36	16	—	20	—	—	—	—
Other palliative procedures	22	4	1	17	—	—	18·2	5·5
Exploration only	233	55	1	175	—	2	23·6	0·6
Total operations	691	206	44	424	6	11	29·8	9·3

* Operation fatalities are excluded in calculating survival rate.

Table VIII.—Mayo Clinic—Hospital Mortality and Survival Rate
(Extracted from *Tables XXI* and *XXV* in Walters et al., 1942)

Operation	Patients	Hospital Deaths	Patients Who Survived Operation*	Survived Five Years	Percentage of Traced Cases†
		per cent			
Total gastrectomy	27	66·7	6	—	—
Billroth I	170	11·2	136	47	34·8
Billroth II	437	17·6	358	100	28·1
Anterior Polya	659	17·8	485	119	24·8
Posterior Polya	1264	15·2	808	232	28·9
Resection by all methods	2772	16·2	1968	564	28·9
Palliative operations	1039	12·3	802	9	1·1
Exploration only	2431	4·4	1971	12	0·6
Total surgical intervention	6242	11·0	4741	585	12·5

* Includes only patients operated on five or more years previously.
† Hospital mortality is excluded in the calculation of survival rates.

Table IX.—Operability and Resectability Rates by Age (London)

1	2	3	4	5	6
Age	Number of Patients	Percentage Distribution of Age Groups	Operation Performed	Radical Operation	Operation Mortality of Radical Operations
			per cent	per cent	per cent
Under 40	75	5·3	78·7	30·7	4·3
40–49	159	11·3	61·6	28·3	17·8
50–59	388	27·6	61·1	21·6	41·7
60–69	512	36·5	49·0	16·2	38·6
70 and over	271	19·3	17·0	3·0	50·0
Totals	1405	100·0	49·2	17·3	32·9

For radical operations $\chi^2 = 67{\cdot}42$. $P < 0{\cdot}001$. Mean age = 60·3.

Age in relation to Operability and Operative Mortality (*Table IX*).—In this table the patients are arranged in six age-groups, showing the

percentage of operations and of radical operations in each age-group with the operation mortality of the radical operations.

Table X gives the corresponding figures for the Mayo Clinic series.

Table X.—Surgical and Resectability Rates by Age (Mayo Clinic) (Compiled from Walters et al., 1942, *Tables XVIII* and *XX*)

1	2	3	4	5	6
Age	Number of Patients	Percentage Distribution of Age Groups	Operation Performed	Resection Performed	Hospital Deaths after Resection
			per cent	per cent	per cent
Under 40	750	6·9	66·5	27·6	4·8
40–49	2217	20·4	58·5	25·4	9·6
50–59	3622	33·3	60·5	27·4	16·5
60–69	3404	31·2	53·7	24·4	21·5
70 and over	897	8·2	47·7	20·0	24·0
Totals	10,890	100·0	57·3	25·5	16·2

Mean age = 56·2

The figures in column 3 show that the London patients were older than those in the Mayo Clinic series, 55·8 per cent of the former were over 60 years of age and 39·4 per cent of the latter. Up to the age of 50 years the proportion of patients submitted to radical operation was higher in London than in the Mayo Clinic, from 50–60 years it was 6 per cent lower, and for later ages lower still. A striking feature of the Mayo Clinic figures is the comparative uniformity of the percentage of resectable growths in all age-groups and the high proportion of patients of 70 years of age and upwards who underwent resection, in marked contrast to the London figures. For all age-groups, except the youngest, the London figures for operative mortality, which included all deaths within 30 days from any cause, were about double the Mayo Clinic figure, which included all deaths in hospital.

Table XI.—Interval from First Symptom to time of Gastrectomy

Interval	London		Mayo Clinic*	
	Number	Percentage	Number	Percentage
0–3 months	51	21·0	403	14·5
3–6 months	47	19·3	497	17·9
6–12 months	63	25·9	342	12·3
Over 12 months	63	25·9	1530	55·3
Not known	19	7·8	—	—
Total	243	99·9	2772	100·0

* Compiled from Walters et al., 1942, *Table V*.

Delay in Diagnosis.—The delay due to failure to seek medical advice early or to failure to send patients promptly for investigation has been dealt with above, where it was noted that the figures for the 691 operated patients showed no significant differences from those for all patients.

Duration of Symptoms at the Time of Gastrectomy (*Table XI*).—In this table the duration of symptoms deduced from the patients' statements in the 243 cases submitted to gastrectomy is set out and contracted with the corresponding figures from the Mayo Clinic. These two sets of figures are not strictly comparable, as in 19·6 per cent of the London patients there was a history of previous dyspepsia, which may or may not have been caused by an early cancer, and if counted as such would increase the numbers with intervals of over 12 months. In London only 40 per cent of the patients had had symptoms for less than six months, and only 32 per cent of the Mayo Clinic patients.

Location of Growth (*Table XII*).—This table shows the differences in resectability, operation mortality, and survival rate between the regions of the stomach.

Loss of Weight and Operability (*Table XIII*).—Figures are given showing the effect of loss of weight during the six months prior to admission to hospital on the operability and resectability rate.

Table XIV shows the resectability rates in patients who had no palpable abdominal tumour and in those who had mobile and fixed tumours respectively. 51·9 per cent of the patients who underwent radical operation had no palpable tumour, about the same

Table XII.—Percentage of Radical Operations, Operative Mortality and Survival, by Regions

Region	Number of Patients	Radical Operations		Operation Mortality	Survived Five Years* Percentage of Traced Cases
		Number	Percentage	Percentage	
Pylorus	470	168	35·7	25·0	21·1
Midgastric	287	61	21·3	41·0	30·3
Cardiac	114	12	10·5	91·6	—
Unknown	534	2	0·4	100·0	—

* Operation deaths are excluded in calculating survival rates.

percentage as Walton (1930) found. Figures from the Mayo Clinic for comparison with *Tables XII*, *XIII*, and *XIV* are not available.

Table XIII.—Loss of Weight, Operability, and Resectability

Weight Loss	Number	Operation Performed	Radical Operation Performed	
			Number	Percentage
		per cent		
No weight loss	54	70·4	18	33·3
Moderate weight loss, up to 2 st., or one-sixth of body-weight	246	59·8	62	25·2
Great weight loss, over 2 st., or over one-sixth of body-weight	272	56·3	59	20·9
Weight lost, but amount not known	738	42·4	94	12·7
Not stated	95	36·8	10	10·5

For radical operations $\chi^2 = 27{\cdot}8$. $P < 0{\cdot}001$.

Table XIV.—Presence of Palpable Tumour and Resectability

Tumour	Number of Patients	Percentage of all Patients	Radical Operation Performed	
			Number	Percentage
No tumour	584	41·6	126	21·6
Mobile tumour	312	22·2	86	27·6
Tumour mobile on respiration	142	10·1	16	11·3
Fixed tumour	234	16·6	11	4·7
Doubtful tumour or not stated	133	9·5	4	3·0

For radical operations $\chi^2 = 79{\cdot}0$. $P < 0{\cdot}001$.

Lymph-node and Abdominal Metastases (*Table XV*).—In this table the percentage of patients in whom metastases were found at operation is arranged in accordance with the type of operation performed.

The conclusion to be drawn from a study of *Tables IX*, *XIII*, *XIV*, and *XV* is that the London patients were on the average older than those seen at the Mayo Clinic and the disease more advanced. The former also include many patients who were

Table XV.—Operation Findings—Metastases

Metastases	Total Cases 691		Resections 243	Palliative Operations 215	Explorations 233
	Number	Percentage			
			per cent	per cent	per cent
No metastases noted	124	17·9	34·2	12·1	6·4
Lymph-nodes—local	338	48·9	60·5	45·6	40·0
Lymph-nodes—retro-peritoneal	152	22·0	3·7	24·6	38·6
Not stated	77	11·1	1·6	17·3	15·0
Metastases in liver	113	16·4	—	16·3	33·5

Table XVI.—Carcinoma of Stomach, 1907–38

Location	Total Cases 6242		Resections 2772	Palliative Operations 1039	Explorations 2431
	Number	Percentage			
			per cent	per cent	per cent
No metastases noted	2319	37·2	45·3	37·2	27·8
Lymph-nodes—stomach	3161	50·6	53·5	52·2	46·8
Lymph-nodes—retro-peritoneal	417	6·7	1·1	12·6	10·5
Liver	747	12·0	1·9	12·8	23·1

The findings in the Mayo Clinic series are set out in *Table XVI* (extracted from Walters et al., 1942).

Comparison of *Tables XV* and *XVI* shows that in the London series the percentage without lymph-node metastases at the time of operation was 19 per cent less than in the Mayo Clinic series and that in the resected cases it was 11 per cent less. The percentage of patients in whom metastases were found in the liver is higher in the London series.

admitted to hospital in the very late stages of the disease, whereas the American patients must have been able to undertake the journey from their homes to the Clinic, thus introducing an element of selection.

Estimation of Survival after Surgical Treatment (*Table XVII*).—Dr. Percy Stocks, Medical

Statistician, General Register Office, to whom this question was referred, advised that in comparing survival rates of cancer patients treated by operation with those treated by other means or not treated, a fallacy is introduced if operation fatalities are excluded from the treated group while leaving in patients who died within a short period without treatment, as the operation fatalities must be taken account of in weighing up the patient's chances of living five years. He therefore advised the use of an actuarial method, which means calculating from a life table the total months expected to be lived during the five-year period by a group of persons in the general population having the same sex-age distribution as the group of patients dealt with, from which the mean is calculated. The mean number of months actually lived by the group of cancer patients from first symptom to death or the end of the five-year period, whichever happens first, is calculated and expressed as a percentage of the normal expected for that group, making allowances for cases followed up for less than five years. In *Table XVII* the expectation of life in months worked out in this manner is shown for the following five groups of cases :—

Group A.—61 cases of pyloric carcinoma *without* lymph-node metastases treated by partial gastrectomy.

Group B.—24 cases of midgastric carcinoma *without* lymph-node metastases treated by partial gastrectomy.

Group C.—91 cases of pyloric carcinoma *with* lymph-node metastases treated by partial gastrectomy.

Group D.—32 cases of midgastric carcinoma *with* lymph-node metastases treated by partial gastrectomy.

Group E.—All cases of known duration, treated or untreated.

These figures show that partial gastrectomy in the early stages, before the lymph-nodes were involved, gave an expectation of survival for five years of 60–63 per cent of normal, whilst after involvement of the lymph-nodes the expectation was reduced to 40–43 per cent of normal.

Table XVII.—EXPECTATION OF FIVE-YEAR SURVIVAL

GROUP	*A*	*B*	*C*	*D*	*E*
Number of cases	61	24	91	32	1255
Mean number of months lived in 5 years from onset — Maximum possible	59·41	58·00	59·74	60·00	59·88
Mean number of months lived in 5 years from onset — Expected	56·61	54·65	56·42	56·99	54·57
Mean number of months lived in 5 years from onset — Actual	34·36	34·66	24·33	23·03	14·90
Percentage of expected	60·69	63·42	43·12	40·41	27·44

The mean actual duration of 1189 fatal cases of known duration in months was 12·42 ± 0·33, standard deviation 11·18 ± 0·23.

Survivors.—There were 56 patients surviving after five years (4·03 per cent of all cases). Of these, 36 had been treated by partial gastrectomy, 7 by palliative operations, 2 by radiotherapy, 1 had exploratory laparotomy only, and 10 had not been treated. Details of the 36 patients who had had partial gastrectomy performed are given in *Table XVIII.*

The mean age of the 17 male survivors at the time of operation was 50·2 years and of the 19 females 53·6 years. The mean duration of symptoms at the time of operation was less than six months in 35 per cent of the males and in 26 per cent of the females, from 6–12 months in 47 and 31 per cent respectively.

Table XVIII.—PARTIAL GASTRECTOMY—SURVIVORS

RADICAL OPERATIONS		OPERATIVE MORTALITY		SURVIVED FIVE YEARS*	
Sex	Number	Number	Percentage	Number	Percentage of Traced Cases
Male	143	53	37·8	17	19·8
Female	100	27	27·0	19	27·1

* Hospital mortality is excluded in the calculation of survival rates.

At operation 10 (58·8 per cent) of the male patients and 13 (68·4 per cent) of the females were found to have no metastases in the lymph-nodes. The diagnosis was microscopically verified in all but 3 of the 36 patients.

The mean age of the 10 survivors who were not submitted to operation was 64·2 years. Two patients refused the exploration which was advised and one underwent gastro-enterostomy subsequently. The diagnosis in all cases was based on a positive X-ray report and in 5 there were gastroscopic examinations, in 1 of which the condition was pronounced to be malignant. There were no biopsies. A definite opinion that the condition was non-malignant has since been given in 4 patients and appears to be justified in the others.

Basis of Diagnosis (*Table XIX*).—This table shows the evidence on which the diagnosis was based in all 1405 cases.

There were 34 patients in whom the nature of the case was not diagnosed clinically, but was revealed at operation or post-mortem. There were, in addition, 24 patients in whom the diagnosis was subsequently changed (after operation in 1 case, on post-mortem evidence in 5 cases, and in view of the clinical course of the case in the other 18), and the cases were deleted from the register before the end

of the five-year follow-up. Adding the 10 survivors referred to in the last paragraph, the percentage of wrong diagnoses in the whole series was 2·4 per cent.

Cancer supervening on Peptic Ulcer.—No attempt was made to draw conclusions on this point from the histories, as sufficient details were not available. However, the histological report suggested that the cancer supervened on a peptic ulcer in 40 cases, 8·6 per cent of those in which a histological examination was made. Of these patients, 23 had growths in the pyloric region and 17 in the midgastric region. In 10 patients there was a definite history of treatment for gastric ulcer and in 10 there was a long history of indigestion.

Table XIX.—Basis of Diagnosis

	Number	Percentage
Clinically Malignant :—		
Confirmed by histological and/or post-mortem examination	544	38·7
Confirmed by appearance of metastases	413	29·4
Based on clinical evidence only	415	29·5
Clinically Benign :—		
Proved malignant by histological examination	24	1·7
Proved malignant by appearance of metastases	9	0·6

SUMMARY

1. The main findings in a series of 1405 patients with cancer of the stomach treated in the hospitals of London during 17 months in 1938 and 1939 are reviewed.

2. The operability rate in these patients was 49·2 per cent and the resectability rate was 17·3 per cent.

3. The operation mortality for all radical operations averaged 32·9 per cent, ranging from 25·4 per cent for the Polya method of partial gastrectomy to 90·0 per cent for total gastrectomy.

4. The survival rate for all radical operations averaged 23·1 per cent of traced cases, after excluding operation fatalities, ranging from 21·5 per cent for the Polya method to 44·4 per cent for the Billroth I method. These figures are compared with those published by the Mayo Clinic.

5. Statistics of age incidence, weight loss, frequency of lymph-node metastases, and other factors are analysed and compared with similar figures from the Mayo Clinic, leading to the conclusion that the patients in the London series were on the average older and the disease more advanced.

6. Estimation of survival by an actuarial method shows that resection before the lymph-nodes were involved gave 60–63 per cent of normal expectation of life over a five-year period of observation. After involvement of the lymph-nodes, resection gave only 40–43 per cent of normal expectation. The average for all cases, including those not treated, was 27·4 per cent of normal.

7. Details of 36 patients who survived five years after partial gastrectomy are examined. Their mean age was 3–6 years less than the general mean of those operated, and 58–68 per cent had no lymph-node metastases at the time of operation. Females showed the best survival rate.

I have to thank the British Empire Cancer Campaign for permission to make use of the case records collected by the Clinical Cancer Research Committee, and Dr. Percy Stocks for help and advice on statistical points.

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LESION OF THE INTERVERTEBRAL DISK CAUSED BY LUMBAR PUNCTURE

By ALFREDA H. BAKER

Theoretical considerations would lead one to expect that in difficult lumbar punctures the needle might enter and injure the intervertebral disk. In the child such injury is more likely than in the adult because the disk in children is a more resilient structure, the nucleus pulposus is of a more fluid consistence and under greater tension. Injury to the intervertebral disk is not, however, a hazard of lumbar puncture that is usually regarded as important, nor is it generally recognized that its consequences may be serious. The case history related here does, therefore, serve to draw attention to a little-recognized injury and one which should be known to all who use lumbar puncture in diagnosis and treatment. Charles Pease (1935) gave a very good account of the mechanism and effects of the injury. His paper does not seem to have been followed by any widespread interest in the American medical press and is little known in this country.

CASE HISTORY

B. C., aged 4 years, was admitted to Oster House Emergency Hospital, St. Albans, under the care of Dr. Ursula James, on Jan. 9, 1945, for investigation of the cause of mild fits. These fits, apparently epileptiform in type, have not been a marked feature of the case and

have no significance in the after-history. In the course of the examination of the C.N.S., lumbar puncture was done on Jan. 11 and Jan. 12. This was successful only after several attempts. More than one interspinous interval was punctured. He was discharged on Jan. 15. Five days later his mother brought him to hospital because she had found that he had backache. The child was admitted for one night for observation. A radiograph taken on that day was reported as showing no abnormality of the spine (*Fig.* 526). Lumbar puncture was repeated and this time no difficulty was encountered. The child seemed well and was sent home on Jan. 22. The cerebrospinal fluid was normal.

One week later the mother brought him back and this time she was seriously alarmed because he was listless and unwilling to sit up or walk. He cried out in his sleep and complained of pain in his back when moved. He was re-admitted at once (Jan. 29). The temperature on admission was 99°; he was pale and retful and looked apprehensive. The heart and lungs were clear, the abdomen soft, and the reflexes present and equal on the two sides. No muscular tenderness was found anywhere and there was no tenderness of the spine. All the same, the child resented being touched or moved, and although he moved his legs as he lay in bed, passive flexion of the spine, by bringing the knees upwards on to the chest, was very painful. The child's movements were most abnormal. He walked cautiously, holding his back very stiff, and when asked to sit up in bed, he raised himself from the lying to the sitting posture by supporting his weight on his hands with his elbows extended. He awakened at intervals during the night screaming with pain.

I was asked to see him for the first time on Feb. 2. It was obvious that he had an acute spinal lesion, but the nature of the lesion was obscure. Radiography of the spine was repeated (that is, 11 days after the first X-ray examination), and now showed a slight narrowing of the intervertebral space between L.2 and L.3 (*Fig.* 527). There was no X-ray evidence of a bone lesion. The

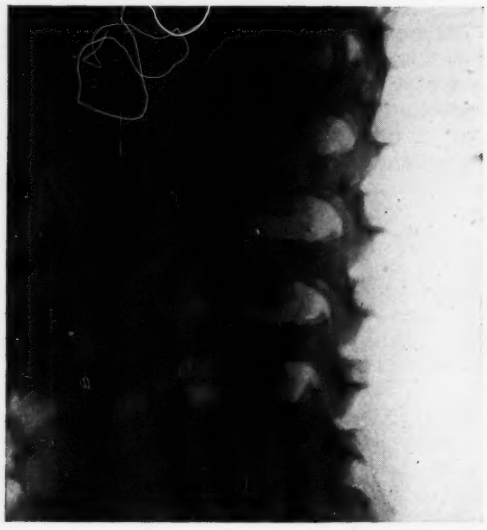

FIG. 526.—Radiograph, Jan. 20, 1945, after the onset of backache.

FIG. 527.—Radiograph 11 days after the onset of symptoms. Narrowing of space between L.2 and L.3.

FIG. 528.—Radiograph 19 days after onset of symptoms. Marked narrowing of space between L.2 and L.3 and between L.3 and L.4.

FIG. 529.—Radiograph showing erosion of upper surface of L.4 6½ weeks after onset.

temperature was now 100°, the W.B.C. 10,875, and the Mantoux test was negative in 1–1000 and 1–100. The next day the child was put in a plaster bed.

The clinical history during the next week was complicated by a sharp attack of chicken-pox, with a well-marked rash and a few signs in the chest. For ten days he had an irregular temperature, at times rising as high as 102°. It was difficult to decide how far the febrile reaction was accounted for by the chicken-pox, and how far, if at all, it was due to his spinal lesion. The progress of the spinal lesion is best followed on the radiographs. These show that fairly rapid progression of the original lesion between L.2 and L.3 was complicated by narrowing

FIG. 530.—Radiograph, Oct. 10, 1945. Bone healed and subluxation corrected with permanent narrowing of intervertebral spaces.

of the disk between L.3 and L.4 (*Fig.* 528) and that by March 6 there was slight erosion of the upper surface of the body of L.4 (*Fig.* 529). By April 6 this slight erosion was surrounded by sclerosed bone, and the alinement of the vertebræ had improved. This improvement in definition continued, and the last radiograph, on Oct. 10, showed a well-defined erosion in the upper surface of L.4, but no evidence of activity of the lesion.

A mild pyrexia continued when the attack of chicken-pox had subsided, the evening temperature being about 99°. It was thought possible that the child might have a low-grade staphylococcal osteomyelitis of the spine and he was therefore treated for five days with penicillin by continuous intramuscular drip. He had 50,000 units daily from Feb. 13 to Feb. 18. He became afebrile on Feb. 20, and, with the exception of five days from March 25 to March 29, he remained afebrile for the rest of his illness. During those five days the temperature rose to 100° or 101° on three occasions and the child complained of backache and was restless. His health from that date steadily improved, and during the last weeks in the plaster bed he was so active and lively that it was extremely difficult to keep him recumbent. Treatment in the plaster bed was maintained until June 22, i.e., for five months. From June 22 to Aug. 7 he was ambulant, wearing a plaster jacket. He has had no treatment since. Flexion of the lumbar spine was somewhat limited when he was seen in November, 1945. He appears to have very slight functional disability, despite the marked skeletal changes shown in the radiograph (*Fig.* 530).

DISCUSSION

The important points in the history of this case are the onset of backache a few days after the performance of a difficult lumbar puncture, the rapid progression of the radiological evidence of spinal injury, and the apparent value of penicillin in the early stages of treatment. Experience of this case had made me view lumbar punctures, in children especially, with added respect. In the event of backache following a lumbar puncture, whether for diagnosis, treatment, or anæsthesia, a radiograph of the lumbar spine should be done, and if negative, should be repeated within ten to fourteen days. The literature on the subject of lumbar puncture injuries is not extensive. Pease (1935) seems first to have recognized the real significance of the sequence of lumbar puncture and prolapse of the intervertebral disk. Billington (1924) had previously discussed the relationship between spondylitis and lumbar puncture in cases of meningococcal meningitis. He said, " the spinal needle may easily afford a direct means of inoculating the lower lumbar vertebræ and disks with the meningococcus ". Of the 35 cases of spondylitis in his series, 8 had partial or complete destruction of a disk in the lumbar region. Pease allows that inflammatory reaction may be set up in the bony and articular elements of the spine, but he is obviously more impressed with the mechanical effects of the injury inflicted by the needle, and it is to this that he attributes the narrowing of the disk. His account of the condition is based on 12 cases. In 3 cases, all children, he gives a complete clinical history. The spinal puncture was done in one case to inject air for an encephalogram, in the second for the administration of serum in a relapsing case of meningitis, and in the last for diagnosis in a case of poliomyelitis. Pease relates his experience in yet another case which was admitted moribund from miliary tuberculous meningitis. A lumbar puncture was done for diagnosis and the needle met an obstruction. An immediate radiograph was taken with the needle in situ. It was found that the needle had penetrated the intervertebral disk and was impingeing on the inferior border of the fourth lumbar vertebra. The needle, after withdrawal, was found to contain material from the nucleus pulposus. Fortunately, a radiograph had been taken before the lumbar puncture and was normal. The radiograph taken immediately after the needle was withdrawn showed a narrowing of the intervertebral space between the fourth and fifth lumbar vertebræ.

Milward and Grout (1936) reported 5 cases, all in adults, whose ages varied from 24 to 51 years. In these patients, lumbar punctures had been done for induction of spinal anæsthesia and the latent period between the puncture and the onset of symptoms varied considerably. The symptoms were, in all cases, severe backache, rigidity of the spine, spasm of the erector spinæ muscles with the spine in a flexed position, and tenderness found on pressure over the spines of L.2, 3, and 4. Milward and Grout conclude that the initial injury is caused by the lumbar puncture needle impingeing on the annulus fibrosus, and that this is followed by an inflammatory reaction in the disk leading to a gradual escape of nucleus pulposus.

Gellman (1940) describes one case following several unsuccessful attempts at lumbar puncture for diagnostic purposes in a syphilitic girl aged 14.

Everett (1942) agrees that the probable cause of the condition is a slow seepage of the nucleus pulposus through the annulus fibrosus. This, he says, may occur directly through a tear in the annulus fibrosus, or by weakening of the annulus through an inflammation set up by the introduction of the needle. He has experience of 3 cases, 2 following diagnostic lumbar punctures, and 1, spinal anæsthesia.

Epps (1942) relates the history of a man who had five punctures done for meningitis, the last of which took thirty-five minutes. The patient complained of shooting pains down his legs as repeated attempts were made to pierce the theca. Three to four weeks later sudden severe low backache occurred, which caused him to collapse in three days.

The history of all these cases is of severe backache following a lumbar puncture, and, sooner or later, disabling the patient. The cases following spinal anæsthesia seem to show a longer latent period between the puncture and the onset of symptoms, and on the whole the symptoms seem to come on more rapidly in children than in adults. The X-ray findings are always of a narrowing of one or more intervertebral disks. Some cases show minor lesions of the vertebral bodies adjacent to the affected disks. In my case there was a tendency to subluxation. Opinion is almost unanimous that the initial lesion is a tearing of the annulus fibrosus by the needle; the part, if any, played by sepsis is not clear. Most authors content themselves by citing 'inflammation' as a possible or probable contributory factor. Where the puncture has been done in a case of meningitis, the organism infecting the meninges is a possible cause of the inflammation of the disk. In my case the clinical improvement of the child after a short course of penicillin lends support to the view that a low-grade sepsis did, in fact, complicate the case. The mechanical factor seems on all counts to be much more important, and persistence in attempts at lumbar punctures by an unskilled operator is most certainly to be avoided. These cases provide a warning against extreme flexion of the spine when the needle seems to meet an obstruction. The possibility must be kept in mind, more especially in children, that this may lead to increased prominence of the disk backwards, and increased danger of its injury by the needle.

Treatment.—A few of the less severe cases have been successfully treated by rest in bed for a matter of weeks. For all severe cases some type of spinal support is essential. The best form of treatment is probably a plaster-of-Paris bed for at least three months, followed by a plaster jacket for a further three months. Full recovery can be expected if the treatment is efficient.

SUMMARY

A case is described in which diagnostic lumbar puncture in a child was followed within a few days by severe backache and rigidity of the spine. Radiographs demonstrated the rapid development of prolapse of the intervertebral disks. Treatment by spinal support was successful. The aetiology of the lesion is discussed.

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A REPORT ON FOUR CASES OF CONGENITAL GENU RECURVATUM OCCURRING IN ONE FAMILY

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THE condition known as congenital genu recurvatum or congenital dislocation of the knee was described as early as 1822 by a Swiss observer, Potel.

According to the literature on the subject, the condition consists of a fixed hyperextension of the leg at the knee-joint, often associated with other congenital abnormalities, especially club-foot and congenital dislocation of the hip; the condition may be unilateral or bilateral. Usually the patella remains undeveloped until the condition is corrected and normal functional stresses are restored.

Various theories as to its causation have been advanced, but Middleton (1935), who made a thorough investigation of this condition, came to the conclusion that the condition is due to an intrauterine degeneration of muscles giving rise to a muscular contracture. Nickerson (1945), quoting Berkheiser, states: "In the human being, born with genu recurvatum, the patella fails to develop until the deformity is corrected surgically and natural functional stresses are restored, after which the patella enlarges and develops."

The following series consists of four cases, a coloured woman and her three children. All the children had different fathers; none of the fathers had any congenital abnormality, and, so far as could be ascertained, all the grandparents were normal. It was not possible to obtain any history farther back in the family tree.

CASE REPORTS

Case 1.—J. M., a female child, was first seen in 1937, at the age of 10 months, suffering from bilateral congenital genu recurvatum (*Fig.* 531). Manipulative reduction followed by plaster casts failed to produce satisfactory results. Surgical operation was performed: through a straight incision on the anterior surface of each knee-joint, the quadriceps tendon was dissected out from the muscles; reduction of the deformity was easily accomplished; the joint was held in about 15° of flexion by an assistant; the V-shaped wound was sewn up as a Y, and the skin closed by interrupted silkworm-gut sutures.

The limbs were placed in plaster for six weeks, and, when the cast was removed, there appeared to be some slight tendency for the dislocation to recur. The cast

was renewed and the child allowed to exercise in the casts. At the end of three months she was sent to the electrotherapy department for massage and exercises.

later, on the left knee. The legs were placed in plaster casts; the club-feet were corrected by manipulation and included in the cast. The casts were renewed at intervals

FIG. 531.—*Case* 1. Lateral and anteroposterior radiographs of both knees before operation.

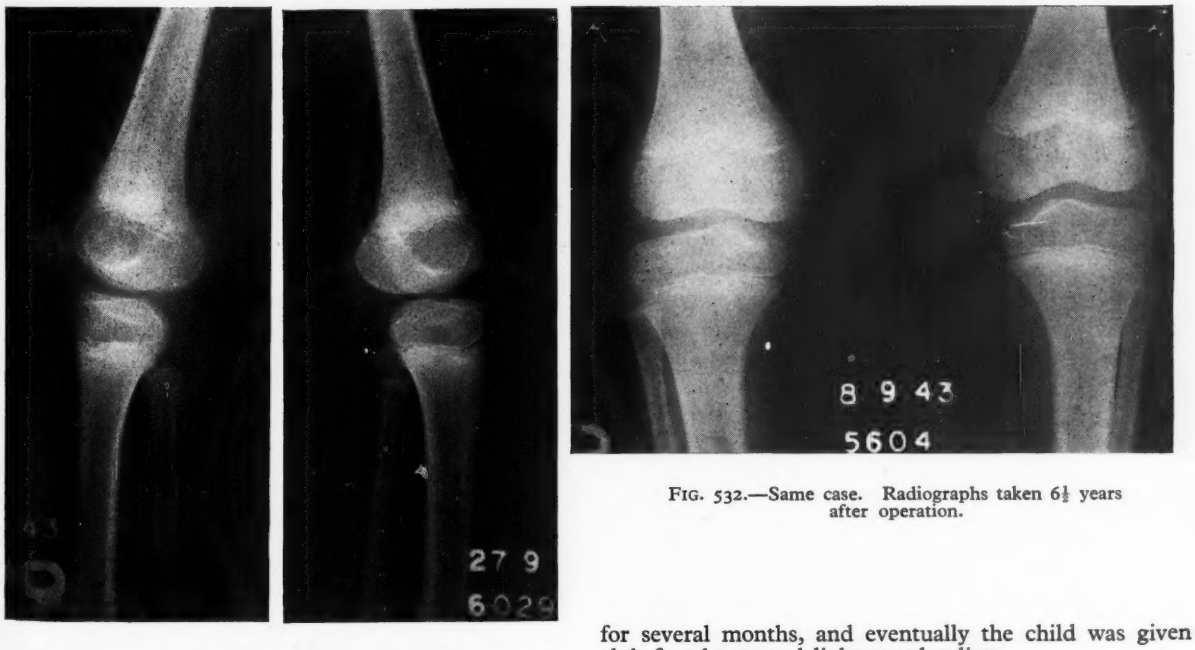

FIG. 532.—Same case. Radiographs taken 6½ years after operation.

When last seen, in November, 1945 (*Fig.* 532), the joints showed normal function and range of movement, but there was a slight degree of bilateral genu valgum.

Case 2.—A. I., a male child, was seen in 1943, at the age of 17 months. He had the following congenital abnormalities: Bilateral genu recurvatum (*Fig.* 533), bilateral talipes equinovarus second degree, a cleft of the posterior half of the soft palate, abnormally large second and third toes of both feet.

Manipulation failed to reduce the dislocation, so operation was done on the right knee, and, eight weeks for several months, and eventually the child was given club-foot boots and light metal splints.

When last seen, in November, 1945 (*Fig.* 534), his gait, legs, and feet appeared normal, and the knees showed a normal range of movement.

Case 3.—C. W., a female infant, was seen in March, 1945, aged 3 months, suffering from: (1) Gastro-enteritis; (2) Bilateral congenital genu recurvatum.

X-ray pictures were taken of both knees (*Fig.* 535), and these show the typical deformity: no treatment was given for the genu recurvatum, as she died of gastro-enteritis shortly after admission.

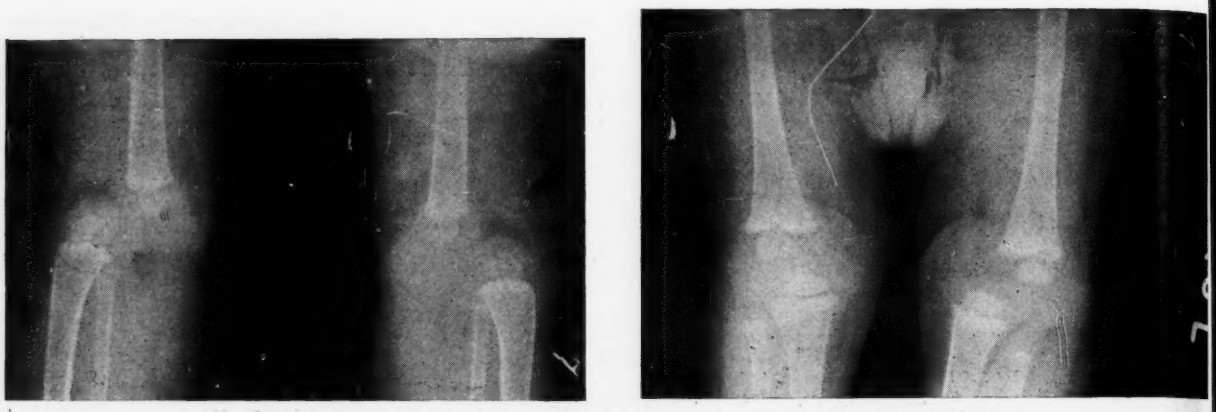

FIG. 533.—*Case* 2. Lateral and anteroposterior radiographs of both knees before operation.

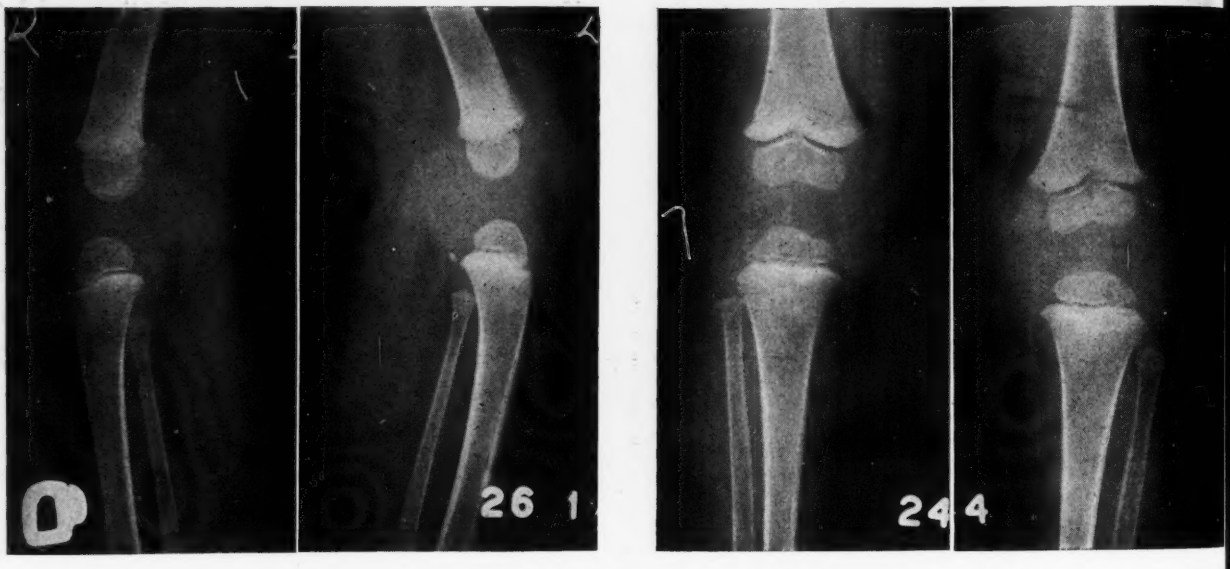

FIG. 534.—Same case. Radiographs taken 1 yr. 4 mth. after operation.

FIG. 535.—*Case* 3. Lateral and anteroposterior radiographs of both knees.

Case 4.—L. W., aged 27 years, the mother of the three preceding cases, was asked to attend at the hospital for examination. She appeared mentally normal, capable of earning her living as a basket-maker, considerably below average height, with unusually short nose with low bridge; marked spinal scoliosis, and some forward bulging of the sternum. The knees showed a small range of movement only, and the condyles of the femora could be felt below and behind the upper ends of the tibia. In addition, there was hyperextension at the elbows, some bony deformity of the heads of the radii; the second and third toes of both feet were abnormally long and webbed at the bases. She walked with a peculiar rocking gait, due to her inability to flex the knee-joints.

Radiographs of the hips (not shown), revealed bilateral coxa valga; radiographs of the knees (*Fig.* 536), show well-developed patellæ on both sides. On the right side, the lower end of the femur is deformed, and displaced backwards and downwards in relation to the tibia; there is a depression on the anterior surface of the femur, just above the condyles, which articulates with the posterior lip of the upper end of the tibia. A similar condition is present on the left side (*Fig.* 537). These patellæ are both well-developed.

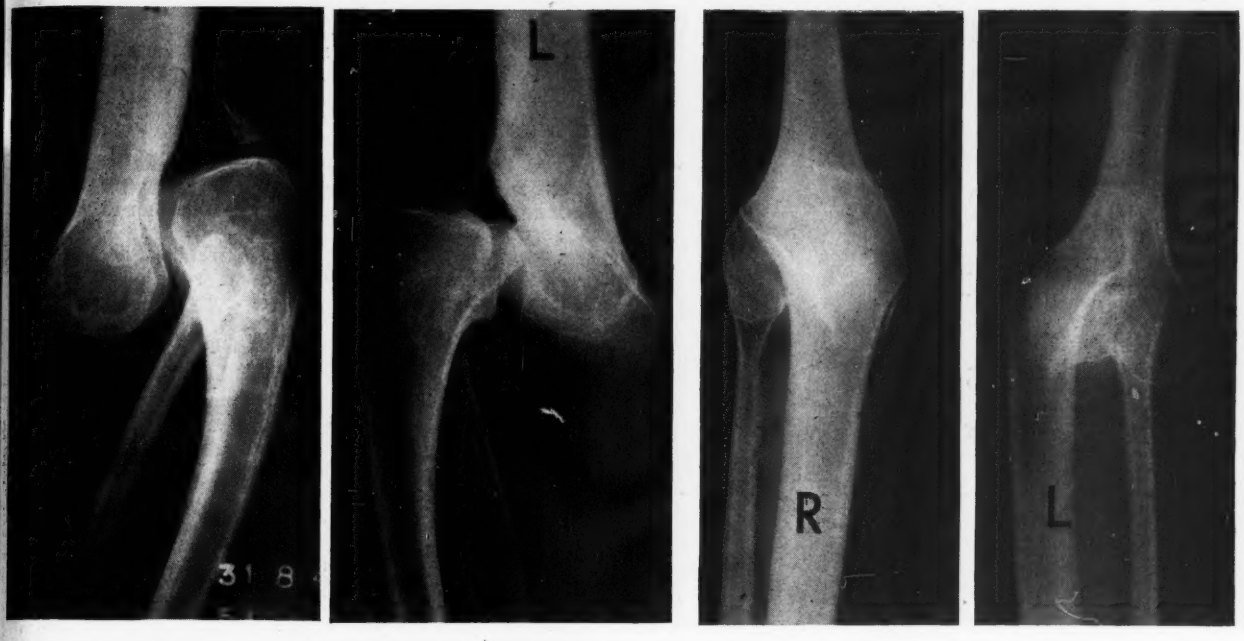

FIG. 536.—*Case* 4. Lateral radiographs of both knees. The lower end of the right femur is behind the upper end of the tibia. Note also the anterior bowing of the tibia, the deformed lower end of the femur, and the presence of well-developed patellæ.

FIG. 537.—Same case. Anteroposterior radiographs

DISCUSSION

Four cases of congenital genu recurvatum are presented in this series, the three children having inherited this congenital deformity through the mother. The family history could not be traced very far. It would have been interesting to know whether any of the great-grandparents had any similar deformities. As the fathers were all different, the likelihood of inheritance from the paternal side may be excluded.

Two of the cases received surgical treatment at an early age, when operation proved the condition to be easily corrected by surgical means, after reduction by manipulation had failed. These two cases, when seen last, appeared to be developing normally, proving that early surgical treatment may result in normal growth with full range of movement.

Case 4 shows one of the end-results of the untreated case, i.e., complete posterior dislocation of the femur at the knee-joint, also that the patella may develop, even though the normal stresses are altered and the deformity remains uncorrected.

Other congenital abnormalities were present in two of the cases (*Cases* 2, 4) which are commonly seen in congenital genu recurvatum.

I have to thank Dr. C. H. Parkin, Radiologist of the Public Hospital, Kingston, for his help and advice in these cases; also several other members of the Staff for their assistance; and the Director of Medical Services for permission to publish this article.

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THE SURGICAL PURSUIT AND REMOVAL OF A METALLIC FOREIGN BODY FROM THE SYSTEMIC VENOUS CIRCULATION

By WILLIAM W. DAVEY, Surgeon, R.A.F.
and GEOFFREY E. PARKER, D.S.O., Surgeon, R.A.M.C.

THIS is the unique tale of the finding, pursuit through the heart and some of the main veins, and final capture of a shell fragment, with survival of the patient.

CASE REPORT

The patient, aged 19, sustained a shell wound in the left clavicular region on Feb. 12, 1945, at 17.00 hr. At 21.15 hr. his condition was "fairly good, but pale, appears to have lost a fair amount of blood, and there is almost a pint on the stretcher and blankets".

Fig. 538.—Radiograph taken on March 5, 1945, showing foreign body in upper anterior mediastinum.

FIRST OPERATION.—Notes at the Field Surgical Unit: "Penetrating wound over point of left shoulder—large hæmatoma over scapula—direction of wound track medial—clavicle intact. The cephalic vein found torn—ligatured. Wound track laid open in search of hæmorrhage. Small metallic foreign body removed but seems very small to have caused wound and another fragment may have entered the chest or mediastinum. Chest appears clear. Penicillin spray to wound and partial primary suture."

These observations of the Forward surgeon were remarkably accurate in view of the subsequent findings.

Penicillin, 450,000 units, was given in the succeeding four days. X-ray examination showed the presence of a metallic foreign body in the upper anterior mediastinum (*Fig.* 538). There were no chest signs or symptoms and no abnormality of the left upper limb was noted except for numbness of the left thumb and forefinger. It was decided to postpone further operation until the superficial wounds were healed. The patient's general condition being satisfactory, he was evacuated to Base.

At Base on Feb. 28 the patient's condition was good. He had a wound extending from the left acromion process to below the inner third of the left clavicle (*Fig.* 539), healed in its inner half, clean and granulating in its outer half. On March 6 X-ray examination confirmed the presence of a foreign body lying in the anterior mediastinum about 1 in. deep to the manubrium at the level of the costochondral junction and lying centrally (*Fig.* 538).

It was decided to embark upon a second operation for the following reasons: (*a*) Complaint of slight retrosternal pain; (*b*) Slight evening rise of temperature; (*c*) Possibility of abscess formation; (*d*) Possibility of secondary hæmorrhage from one of the great vessels in the vicinity.

SECOND OPERATION (G. E. P.).—

First Stage: This began at 10.30 a.m. on March 7 under endotracheal gas, oxygen, and ether. A C-shaped incision exposed the second and third left costal cartilages and the sternum at that level (*Fig.* 539). The second costal cartilage and a portion of the manubrium were resected after separating the left pleura digitally and the foreign body was at once felt lying apparently behind the left innominate vein, above and in front of the arch of the aorta. During the dissection to clear the left innominate vein the fragment was felt to roll away from the surgeon's fingers and after a short search it became apparent that it had disappeared completely from the operative field. This led to the conclusion that the foreign body had been actually within the lumen of the vein

FIG. 539.—Colour photograph taken on Nov. 6, 1945, showing original wound and operation incisions.

(*Fig.* 540), that it had been dislodged by the dissection, and now moved proximally with the blood-stream towards the heart. There was no change in the patient's condition, but the table was at once placed in the reverse Trendelenburg position in an attempt to prevent the fragment from passing from the right auricle to the ventricle, which it was thought would result either in

immediate death from cardiac embarrassment or total infarction of one or other lung by blocking of either main pulmonary artery. Immediate X-ray examination (*Fig.* 541) showed the fragment to be lying in the right auricle

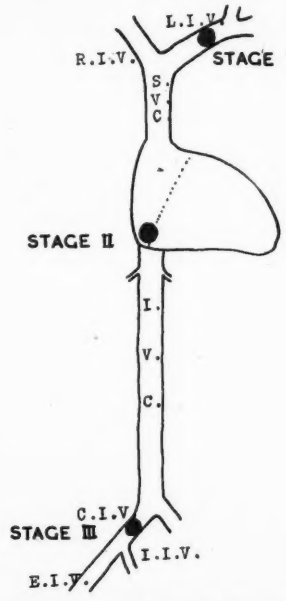

FIG. 540.—Diagram showing the intravascular course of the foreign body.

at approximately the level of the entry of the inferior vena cava. After giving a blood transfusion, the operation was continued one hour later. A further check radiograph confirmed the position of the foreign body (*Fig.* 541).

FIG. 541.—Radiograph taken at 13.00 hr. on March 7, 1945, showing foreign body in the right auricle just above the diaphragm.

Second Stage: The pericardium was exposed through a reverse C-shaped incision incorporating the lower limit of the first incision (*Fig.* 539), the third, fourth, fifth, and sixth costal cartilages and the corresponding part of the left half of the sternum being resected. An oblique incision was made through the pericardium. The heart was exposed and the foreign body felt in the intrapericardial portion of the inferior vena cava (*Fig.* 540). A pair of forceps was introduced into the auricle through a small incision in the middle of a purse-string suture, care being taken to exclude air from the auricle, and the foreign body was grasped in the forceps. It proved, however, to be fixed obliquely and impossible to remove except by a force which would tear the wall of the vena cava or the auricle, or both, and the grip of the forceps was released. Immediately this illusive fragment moved away, passing down the inferior vena cava. To make sure of this at this stage the reverse Trendelenburg position was increased to the maximum which the table allowed. The opening in the auricle was enlarged to admit a finger to be introduced and passed down the inferior vena cava to verify that the fragment had not lodged in the opening of one of the hepatic veins. The auricle was closed in two layers and the pericardium closed by interrupted sutures after insufflation of penicillin-sulphathiazole powder. Radiography now showed the foreign body lying in the right common iliac vein just below the junction of the common iliac veins (*Fig.* 542).

The patient's condition had deteriorated, but no more than might have been expected having regard to the magnitude of the operative procedure and the sudden loss of blood which occurred during the opening of the right auricle. His condition was not such as to render the further pursuit of the fragment too hazardous. It was felt this should be done at once as there was a danger of the foreign body being drawn back into the heart during coughing or post-operative vomiting, when pressure in the great veins is negative and the patient would not be in the reverse Trendelenburg position.

Third Stage: The right common iliac vein was exposed through an oblique extraperitoneal incision parallel to the inguinal ligament and the fragment manipulated digitally from its dangerous position in the common iliac vein into the cul-de-sac of the right internal iliac vein (*Fig.* 540). The vein was ligatured proximally and the fragment removed. It was found to be a jagged shell fragment, half the length of and approximately the same diameter as a Woodbine cigarette (1 × ¼ × ¼ in.).

CONDITION ON CONCLUSION OF OPERATION.—The patient was 4½ hours on the table. He was considerably

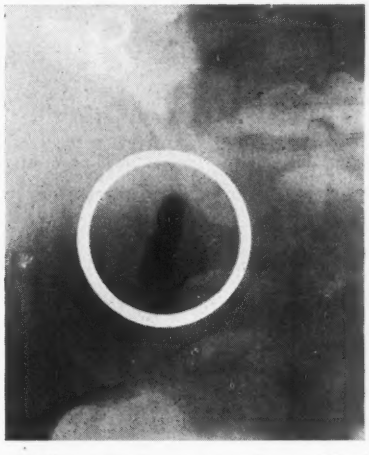

FIG. 542.—Radiograph taken at 14.45 hr. on March 7, 1945, showing foreign body in the right common iliac vein.

shocked and of a clammy waxen pallor. His pulse-rate was 160. Throughout the succeeding 12 hours the pulse-rate remained between 160 and 170 and the systolic blood-pressure between 100 and 120 mm. Hg. Respirations were rapid (36), shallow, and distressed at times, the paradoxical excursion of the skin and subcutaneous tissues which alone constituted the chest wall over the area of the first two incisions, compensating for a considerable proportion of the negative pressure at each contraction of the diaphragm.

PROGRESS.—Post-operative treatment was symptomatic and consisted of continuous oxygen through a B.L.B.

mask, morphine, phenobarbitone, and atropine as indicated. Poor expansion of the lungs and suppression of coughing resulted in a moderate degree of pulmonary collapse at the end of the second post-operative day, but this cleared up with the onset of coughing. On the third day 20 c.c. of blood-stained fluid were aspirated from the pericardium by puncture of the skin overlying it. Continuous oxygen given first through a B.L.B. mask and later by use of an improvised oxygen tent were necessary for the first four days, and its absence led to severe dyspnœa and cyanosis in two minutes. After the fifth day there was a period of relative calm until the eleventh day when the temperature rose intermittently to 101° F. Two days later 2 oz. of sterile blood-stained fluid were aspirated from the pericardium and thereafter convalescence was uneventful.

Five weeks after the operation the patient was able to walk 400 yd. without showing any signs of distress, and he was flown back to England in good condition seven weeks from the day of his marathon operation.

OPERATIVE COMMENT.—During the operation on the auricle extrasystoles were noted, and when lung forceps were applied near the sino-auricular node to steady the auricle for a few seconds a condition of delirium cordis occurred, but this passed off as soon as the forceps were released.

While the finger was exploring the inferior vena cava the patient's condition deteriorated suddenly, presumably from syncope due to diminished venous return to the right ventricle and consequent diminished cardiac output, but recovered quickly when the finger was withdrawn and the auricle closed.

FOLLOW-UP.—Visited at his home on Sept. 25, over seven months from the injury, he is living a normal life and is working as a technician in technicolour. He gets palpitation with running and feels like " an engine rev'd up ". He has discarded the asbestos breast-plate with which he had been fitted to protect the deficiency in his thoracic cage. He says he automatically puts his left arm across his chest in case of trouble. His condition to-day one and a half years after injury is unchanged.

DISCUSSION

A search of the literature reveals several interesting facts. Gregory (1917) describes a similar case, although the intravascular course of the missile was shorter and less rapid and had a fatal termination. A shrapnel ball entered the liver from the right axilla and ultimately entered the inferior vena cava through the hepatic part of the inferior vena cava and reached the right auricle (confirmed by screening). Subsequently during a fit of coughing, associated with severe distress, the foreign body was found to be in the abdomen. A swelling appeared above the right inguinal ligament and pain in the right iliac fossa which suggested appendicitis. Appendicectomy was performed and the shrapnel ball removed from the external iliac vein on the nineteenth day following injury. Death ensued in three days from general peritonitis.

Menuet (1918) records a case of a patient wounded in the right axilla who died on the second day. It was found that a shell fragment had reached the right ventricle via the liver, inferior vena cava, and the right auricle.

Lyle (1917) had a patient with a shell wound in the left thigh who died on the fifth day from generalized anaerobic infection. Post-mortem examination revealed an opening in the femoral vein and the foreign body free in the right ventricle measuring 1·5 × 0·9 × 0·5 cm.

A patient was described by Tuffier (1918) who received a bullet wound in the right lumbar region. Four weeks later radiography showed the missile to be on a level with L.1, 2. Eight days later a radiograph showed the missile in the heart. Attempted removal at this site had to be stopped owing to collapse, and death occurred three days later. Post-mortem examination showed that the bullet had entered the inferior vena cava and come to rest in the wall of the right ventricle.

Following an accidental wound of the abdomen with a 0·38 bullet, Sheppe (1922) performed a laparotomy. He closed multiple small-intestinal perforations and found the bullet resting in front of the vertebral column just above the lumbosacral prominence; as he attempted to grasp it, it disappeared and a massive hæmorrhage ensued from a hole in the inferior vena cava. The patient recovered from the immediate operation but died a few days later from general peritonitis. The bullet was found post-mortem in a fibrin bed near the apex of the right ventricle.

Warthen (1927) made a study of the intravascular fate of metallic foreign bodies introduced into the veins of dogs. He found in all cases they were carried towards the heart. This might take hours or days, but, finally, the heart was reached irrespective of the dog's position or gravity. On reaching the heart the smaller bodies tended to remain there in the right ventricle at the base of the chordæ tendinæ, while the larger ones were carried through to the lungs.

It would appear that the 'normal' course of a foreign body in the venous system is experimentally and clinically towards the heart. This movement can be reversed or impeded by gravity or coughing where a reverse wave of pressure is conducted distally in the inferior vena cava. Free movement of foreign bodies in the superior and inferior vena cava is possible owing to the absence of valves in these veins. Gravity probably succeeded in maintaining the fragment in the auricle and in finally deciding its passage against the blood-stream down the inferior vena cava. Admittedly the force of this stream must have been low in a shocked patient. The maintenance of the foreign body in the auricle might have been achieved even better by placing the patient on his right side (table permitting), in addition to the reversed Trendelenburg position. At all costs the foreign body must be kept from entering the right ventricle, where death has invariably resulted in the cases recorded.

Where surgery is undertaken to remove a foreign body in close apposition to a great vein, it must be stalked with great gentleness, and, if possible, 'trapped' in the vein by proximal occlusion of its lumen. Otherwise, there is a grave risk of onward transmission to the heart.

SUMMARY

A shell fragment, 1 × ¼ × ¼ in., which was lying in the lumen of the left innominate vein passed from there, during operation, into the right auricle and during an attempt to remove it from the auricle, with the patient tilted in the reverse Trendelenburg position, passed down the inferior vena cava to the right common iliac vein and was finally removed

from the right internal iliac vein. As far as the authors know, such a surgical adventure with the survival of the patient is unique in medical history.

We are indebted to Mr. Hennell for the colour photograph.

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THE ELIMINATION OF 'APPARATUS INERTIA' IN THE TREATMENT OF FRACTURES

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AND E. J. NANGLE, BEIT FELLOW, EX CAPTAIN, S.A. MEDICAL CORPS

THE success of the Thomas splint in the treatment of fractures of the femur may be attributed to two main factors—namely: (1) The immobilization of the fracture which it affords; and (2) The degree of mobility which it allows the patient in bed.

In this respect it is of interest to recall the fact that Hugh Owen Thomas himself suspended the splinted limb by means of a system of ropes and pulleys, but that his system of suspension was forgotten and only his splint remembered. It was, however, soon recalled.

Successful methods of suspension of the limb, immobilized in a Thomas splint, were devised by Pearson and Drummond, and by Sinclair during the First World War. Hodgen and Hamilton Russell devised methods whereby the Thomas splint was modified or dispensed with entirely, and each of these methods paid due heed to the two factors mentioned above.

To all these forms of treatment, the term 'balanced traction' has been applied, and E. L. Farquharson (1936) stated: "There can be little doubt that the most effective control of the fracture, combined with the maximum comfort of the patient, is to be obtained by the use of some form of suspended splint which is so counterbalanced that it follows the movements of the patient in bed, without the direction of the traction being appreciably altered."

More recent methods of treatment of fractures of the femur display an increasing tendency to afford maximal mobility to the patient during the time that the fracture is immobilized, and all these methods constitute the most adequate proof of the importance of mobilizing the patient at the earliest possible moment.

There remains, however, the less fortunate patient who is suffering from a fracture or disease which necessitates immobilization in a large plaster-of-Paris cast, such as a hip spica or a plaster bed.

This type of patient has been required to remain in the supine position for weeks or months or even years, and to depend entirely upon the nursing staff for the occasional alterations in position which are essential to maintain comfort, the condition of the skin, renal drainage, etc. Small wonder that he becomes as much a psychological problem as a surgical, and that rehabilitation in the society of his fellow men is a somewhat protracted process.

It is apparent that the principal obstacle to movements is the sheer weight of the immobilizing apparatus, and it is to this factor that we apply the term 'apparatus inertia'.

A method of suspending the limb, immobilized in a Thomas splint, is described, and the method expanded to include all those fractures and diseases of the spine, pelvis, and lower extremities which require immobilization in bed. It eliminates 'apparatus inertia', affords the patient maximal mobility, and does not in any way interfere with the immobilization of the affected part.

The method employs a system of compound pulleys, of the same type as is used by engineers in hoisting weights of great magnitude; for it is only by the use of this type of apparatus that an efficient 'machine' may be obtained.

Details of treatment of the standard types of lesion only are given below, and it is apparent that numerous modifications to suit individual cases may readily be devised.

We first employed this method of treatment in cases which occurred during the final 'push' in Italy in April, 1945, and have continued its use in a wide variety of cases since that time. There have been no contra-indications to its use, and the advantages are discussed below.

Its application to individual types of lesion is as follows:—

A. FRACTURES OF THE HIP AND UPPER SHAFT OF THE FEMUR

A considerable proportion of our cases with the above type of lesion were battle-casualty compound fractures. Immobilization was therefore obtained by the use of the double-hip, plaster-of-Paris spica.

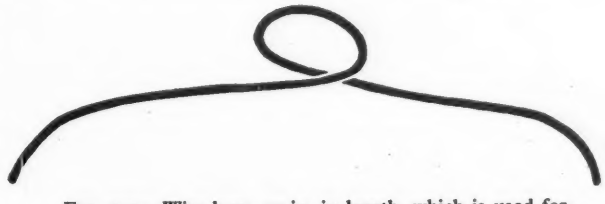

FIG. 543.—Wire loop, 10 in. in length, which is used for incorporation in plaster cast during application, and which forms a 'suspension point'.

Simple fractures of the femoral neck, on the other hand, were 'pinned' with a cortical peg-graft rather than with one or other type of metal nail, as this method of treatment is, in our opinion, more certain

to result in bony union in young adults. Immobilization in the double-hip plaster spica was once again provided.

'Suspension points' on the plaster cast are created during its application, and they consist of stout wire loops at groin and knee level on both sides. The type of wire loop employed is shown in *Fig.* 543 and the limbs of the loop are incorporated in the cast by a few short plaster slabs and a few turns of the plaster bandage.

It is emphasized that the limbs of the wire loops do not encircle the trunk or limb of the patient, but are applied to the anterior aspect of the cast alone. This eliminates the danger of their cutting into the plaster and causing pressure sores.

Occasionally it is necessary to provide a fifth suspension point at ankle level on the affected side, in order that maximum mobility may be obtained, but it is obvious that there will be individual variations for individual cases, and that it is only by a system of trial and error that complete satisfaction is obtained.

The method of suspension of the patient is diagrammatically illustrated in *Fig.* 544 below.

A sling of stout cord is attached to the two wire loops on each side, and one of the wheels of a compound pulley is made to engage upon these slings. The other wheel of this pulley forms part of the suspensory mechanism, and a pulley system with a mechanical advantage of three is employed on each side. This enables the patient to raise and lower himself with ease, and to support himself on the sound leg within a matter of days after operation. The effects of gravity may be reduced to whatever extent one desires by merely adding to or

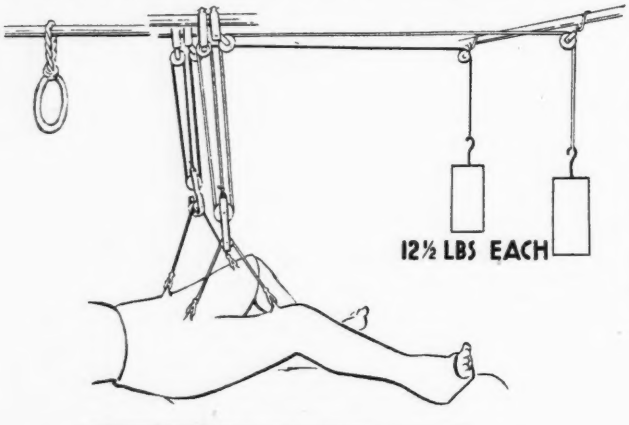

FIG. 544.—Method of suspension of the double-hip plaster spica. Two weights, each with a mechanical advantage of three, afford a total 'lifting power' of 75 lb., which is adequate for the average patient, but may be increased in the case of the old or frail.

subtracting from the weights at the foot of the bed, and in the average type of patient it is found that two weights, each of 12½ lb., which give a lifting power of 75 lb., are adequate. In the old and frail, or in the large and heavy, these may be increased to a point just short of which they will maintain the patient in a permanently suspended position.

Our oldest patient was a male aged 78 years who suffered from congestive cardiac failure at the time of his admission to hospital.

He experienced no difficulty in raising himself from his bed on the day of his operation, after he had been given assistance to the extent of approximately 66 per cent of his body plus plaster-cast weight. There were no post-operative pulmonary or other complications in this case.

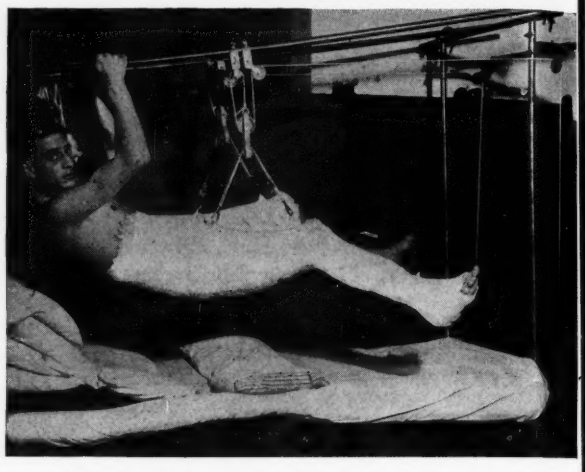

FIG. 545.—Battle casualty (shell wound). Compound subtrochanteric fracture of the right femur. Note the excellent condition of the patient and the ease with which he is able to raise himself. He is also able to stand on the sound leg, and these exercises are performed within a day or two after application of the plaster cast.

It is occasionally necessary to apply traction to a limb which is immobilized in a plaster hip spica. This is readily accomplished by inserting a Steinmann's pin through the tibial tuberosity, and incorporating it in the cast. Sliding traction is then applied to the pin in the standard manner, and it does not in any way interfere with the mobility of the patient.

A photographic reproduction of a patient performing active exercises is shown in *Fig.* 545, and it will be noted that his expression is entirely free from strain, effort, or fear of pain.

When quick-setting plaster-of-Paris is used, it is possible to suspend the patient within an hour or two of the application of the cast, and this is of great value in promoting drying of the posterior half. Other advantages of this form of suspension are discussed below.

B. MID-SHAFT FRACTURES OF THE FEMUR

The method of choice for immobilization of this type of lesion was by the use of the Thomas splint, and skeletal traction from a pin through the tibial tuberosity or skin traction was applied.

Small wire loops are attached to the proximal and distal ends of the limbs of the splint, either by welding or by a few turns of a plaster-of-Paris bandage. The immobilized limb is suspended from these loops by cords leading through the lower wheels of a compound pulley, and the 'rocking action' which is obtained at this compound pulley allows the patient to assume the upright position with ease.

The method is illustrated diagrammatically in *Fig.* 546.

We employ sliding traction from a tibial tuberosity pin as a routine measure, as it is effective and requires

no further adjusting after reduction has been secured. It has the further advantage of permitting a limited range of movement at the knee-joint, by virtue of the hinged joint of the knee-flexion-piece upon

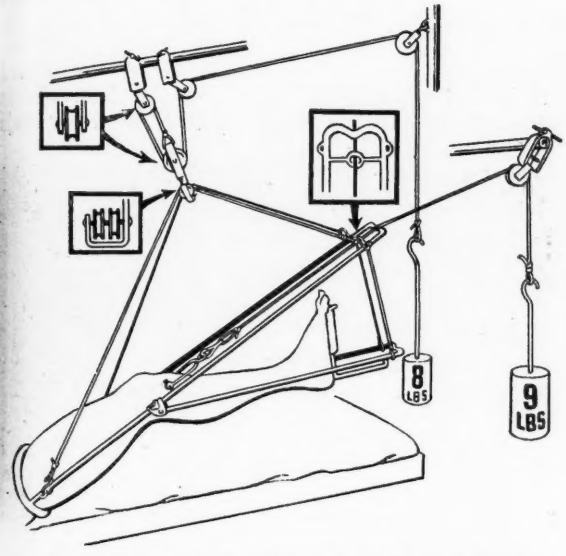

FIG. 546.—Apparatus used in mid-shaft femoral fractures. Sliding traction is employed, and inset shows metal loop at the distal end of the splint for guiding the traction cord and preventing alterations in direction of traction during the movements of the patient. Type of compound pulley used is also illustrated in insets.

which the leg is made to rest. On the other hand, when skin traction is applied, the Thomas splint itself is bent through about 15° at the level of the knee-joint, so that no knee movements are possible.

A guiding loop at the base of the splint, shown in inset in *Fig.* 546, prevents alteration in the line of traction on the limb during movements of the patient, and he is therefore able to swing himself from side to side, as well as to stand upright in bed.

Fig. 547 shows a photograph of a patient 'in action'.

It is realized that many surgeons prefer fixed traction as opposed to sliding, and this may be secured by one of two modifications.

The traction cord may be secured to the base of the Thomas splint and its tension adjusted daily in the usual manner. In this case, a small weight will suffice to ease the pressure of the ring of the splint on the ischial tuberosity and so prevent pressure sores at that site.

A more satisfactory method has, however, been used by us with effect, and it has the advantage of eliminating the need to perform daily adjustments of the tension on the traction cord. It is illustrated in *Fig.* 548.

Accurate fitting of the ring of the splint is ensured in all cases, where necessary, by the insertion of a 'shell' dressing or firm pad of wool between the ring and the ischial tuberosity.

In compound fractures where accurate reduction of the fracture was secured under direct vision prior to delayed primary suture, the reduction was maintained by means of plaster-of-Paris slings rather than calico or canvas, and these then required no further adjustments to prevent the posterior angulation which is so liable to occur with the latter.

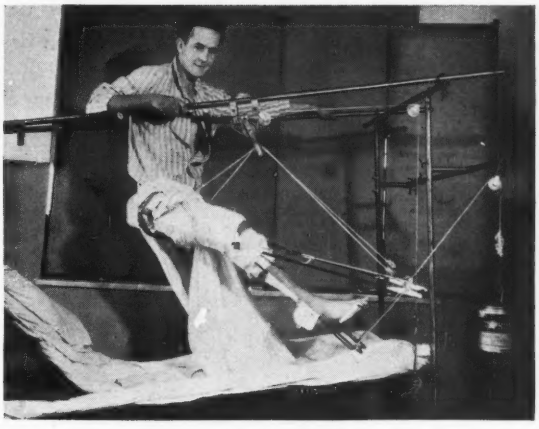

FIG. 547.—Battle casualty (shell wound). Compound fracture of mid-shaft of right femur. The patient stands upright, without the direction of the traction being altered. *Note*: When the patient stands up the direction of traction of the suspending apparatus is in a headward direction, maintaining the apposition of the ring of the splint against the ischial tuberosity.

They were extremely well tolerated, and in no case were they responsible for the development of pressure sores. Posterior angulation, due to severe muscular wasting of the part, was not a serious factor in our series of cases, for the mobility of the patient militated in no uncertain measure against this wasting.

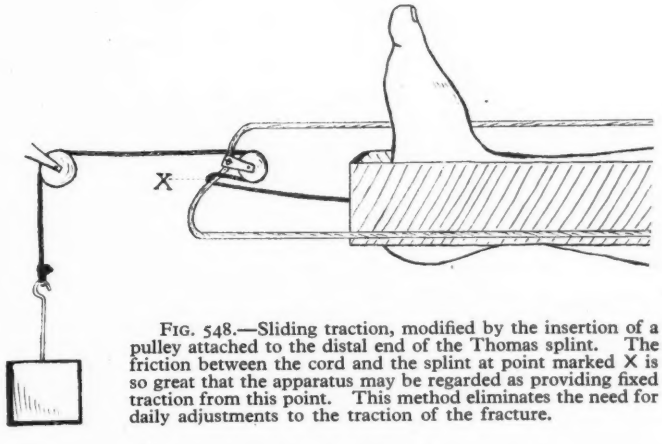

FIG. 548.—Sliding traction, modified by the insertion of a pulley attached to the distal end of the Thomas splint. The friction between the cord and the splint at point marked X is so great that the apparatus may be regarded as providing fixed traction from this point. This method eliminates the need for daily adjustments to the traction of the fracture.

An unexpected finding in our series of cases was the extraordinary small weight which was required to maintain reduction of a fracture.

This can be accounted for by the fact that the degree of mobility of the patient is such that inertia at the pulley over which the traction weight acts is reduced to a minimum. We found that 9–11 lb. was in the majority of cases sufficient to maintain reduction, and in one case we were able to demonstrate distraction of the fracture radiologically with only 11 lb.

C. SUPRACONDYLAR FRACTURES OF THE FEMUR

Supracondylar fractures of the femur are immobilized in a Thomas splint. Skeletal traction in the long axis of the limb is applied by the insertion of a Steinmann's pin through the tibial tuberosity, and this traction is of the fixed or sliding variety.

A second pin is inserted through the small distal fragment of the femur, and vertical traction applied to this pin to prevent posterior rotation of this fragment. This traction is of the fixed variety, and is shown in diagrammatic form in *Fig.* 549.

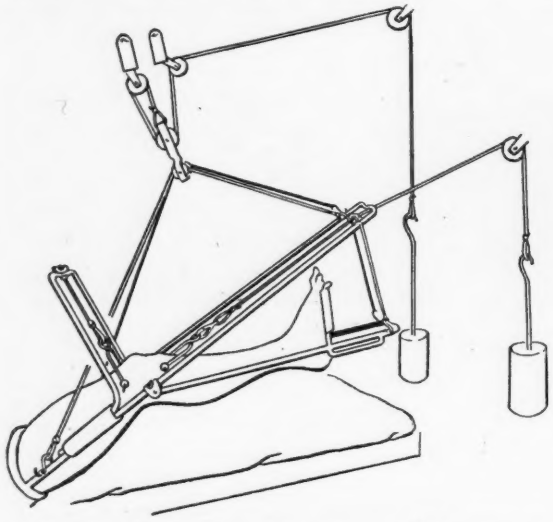

FIG. 549.—Apparatus used for supracondylar fractures of femur. An extra knee-flexion piece, bent to a right angle, is employed to provide vertical traction on the small distal fragment, while longitudinal traction is applied in the usual manner. The splint is suspended as for mid-shaft fractures, and the patient enjoys the same degree of mobility in bed.

It is applied from the distal end of a knee-flexion piece bent to a right angle and attached to the bars of the Thomas splint at knee level by means of a few turns of a plaster-of-Paris bandage. A butterfly nut and bolt allow accurate reduction of the posterior angulation, and counter-traction is provided by firmly bandaging the limb to the Thomas splint in the usual manner.

The splinted limb is suspended in the same manner as above, and the patient enjoys the same freedom of movement.

This method of treatment is of particular value in compound fractures and in fractures which extend into the knee-joint, for it permits movements at this joint within a few days of immobilization, and allows ready access to the anterior aspect of the knee, so that the occurrence of ' adherent patella ' may easily be averted.

Radiographic evidence of reduction of a supracondylar fracture of the femur by this method is shown in *Fig.* 550.

D. COMPOUND FRACTURES INVOLVING THE KNEE-JOINT

These cases were usually due to gunshot or shrapnel wounds penetrating the knee-joint, and immobilization in a Thomas splint with skin traction was the rule.

The limb was then suspended in the same manner as above, and the patient afforded the same degree of mobility.

Cases in which penicillin-resistant organisms were obtained from the joint were found to require the more complete immobilization of a double-hip plaster-of-Paris spica, in order that the limb, if not the joint, might be saved, and they were suspended after the manner of fractures of the hip. It is significant that in no single case treated by this manner was amputation of the limb required, and we feel certain that the promotion of the general health of the patient by this method of treatment was an important factor.

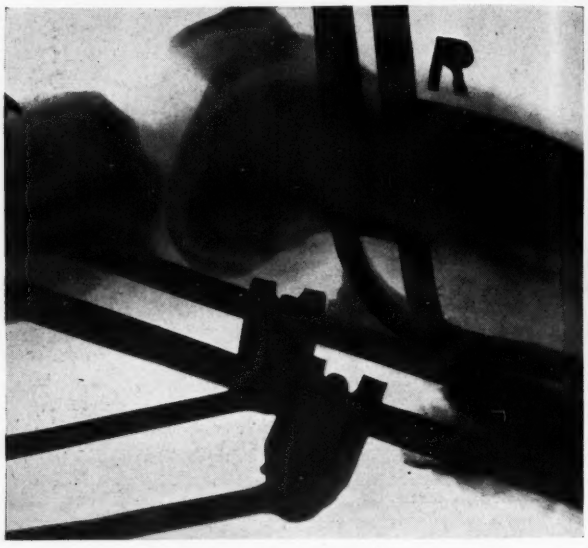

FIG. 550.—Supracondylar fracture of the femur. Control radiograph shows reduction of the fracture by the use of a Thomas splint and double skeletal traction. The bars of the Thomas splint and of the two knee-flexion pieces are shown, as also the Böhler's stirrups attached to Steinmann's pins.

E. FRACTURES OF THE TIBIA AND FIBULA

Two types of fracture of the tibia and fibula are recognized—namely: (1) Fractures in which reduction is stable, and in which no form of immobilization other than an adequate plaster-of-Paris cast is required. These include those cases in which bone-grafting or plating has been performed. (2) Fractures in which the reduction is unstable, and in which continuous traction is required for the initial period of treatment.

In the *stable fracture* an above-knee plaster-of-Paris cast is applied, and two wire loops are embedded in the cast during its application, at knee- and ankle-joint levels. The limb is suspended after the manner shown in *Fig.* 551, and the usual triple-acting pulley employed.

Two advantages are apparent. In the first place, active leg-raising exercises are permitted from the day of the operation, and very soon the patient is able to do this without the assistance of the apparatus at all. Secondly, it permits the most effective elevation of the limb. This is of great value in reducing the œdema of the leg in cases of compound fractures and thereby enabling successful delayed

suture of a wound which would otherwise have required a skin-graft. As soon as local conditions permit, the patient is allowed to walk with the aid of crutches and without taking weight on the injured limb. The use of the apparatus described above contributes substantially towards accelerating this step.

In the *unstable fracture*, where internal fixation is contra-indicated, skeletal traction is applied by means of a Steinmann's pin through the lower end

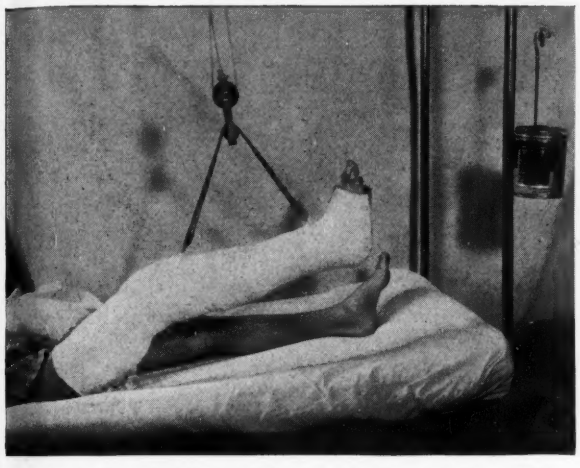

FIG. 551.—Stable type of fracture of tibia and fibula. Wire loops are incorporated in the plaster cast, and the limb is suspended from these loops. Active exercises of the leg commence at once.

of the tibia and fibula, 1 in. above the ankle-joint, and the limb encased in an above-knee plaster-of-Paris cast, incorporating the pin.

A Thomas splint is then applied and the limb suspended after the manner of a fracture of the femur, described above.

Sliding traction is employed, and a weight of 8 lb. is found to be sufficient to prevent shortening in the majority of cases of compound fractures.

This method eliminates the use of the conventional Böhler-Braun type of splint and allows the patient maximum comfort as well as mobility. A diagrammatic representation of the apparatus is shown in *Fig.* 552.

F. FRACTURES OF THE PELVIS

Simple fractures of the pelvis present no problem. Reduction is affected by the Watson-Jones technique, and immobilization secured by means of the double-hip plaster-of-Paris spica. The patient is then suspended in the same manner as high fractures of the femur, and he enjoys the same degree of mobility.

Battle casualties, however, are often of a much more complicated nature. The fractures are compound and comminuted, and are frequently accompanied by lesions of the peritoneum, bladder, or urethra. It is therefore not always possible or desirable to apply an encircling plaster-of-Paris cast during the initial stages of treatment, and yet immobilization of the pelvis is essential to the comfort of the patient. In these cases we adopt one of three forms of treatment:—

1. Where lateral compression of the pelvis is necessary to maintain reduction, a broad canvas or calico sling is applied to the pelvis and the patient suspended in such a manner that the pelvis rests very lightly on the bed. A 'stop' is applied to the suspending weight, to prevent the patient lowering himself any farther on to the bed, but it does not prevent him from raising himself freely. Reduction of the fracture is maintained by the body-weight,

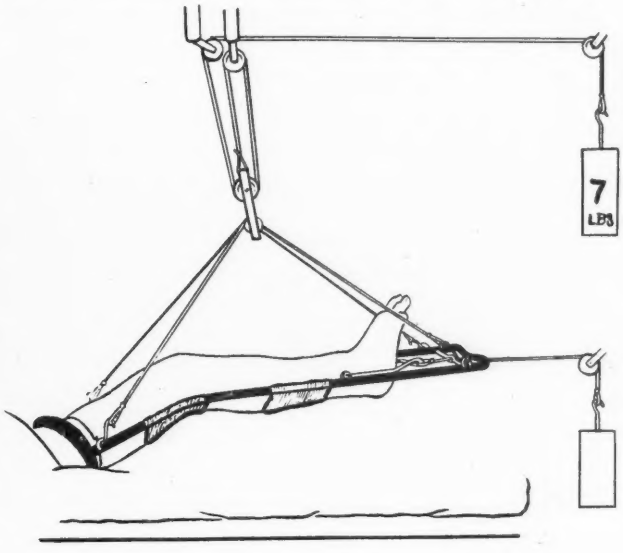

FIG. 552.—Fracture of the tibia and fibula requiring continuous traction. A pin is inserted through the tibia above the ankle-joint and the limb encased in plaster-of-Paris. Sliding traction on a Thomas splint is applied, and the patient afforded maximum mobility by means of efficient suspension of the leg.

and there is ready access to wounds or drainage tubes in the anterior abdominal wall or in the perineum.

2. Where lateral compression of the pelvis is not required, the pelvis is immobilized in a plaster-of-Paris bed until such time as a hip spica may be applied. Suspension of the patient in the plaster bed is described in Section G below.

3. Fractures of the pelvis with concomitant destruction of the acetabulum require continuous traction to prevent upward dislocation of the hip-joint. This may be applied from a Steinmann's pin through the tibial tuberosity, and either a Thomas splint or a plaster hip spica, which incorporates the pin, is employed for immobilization.

G. FRACTURES AND DISEASES OF THE SPINE AND ADNEXÆ

Simple compression fractures of the spine and diseases which require immobilization in a plaster jacket require only a Balkan beam and a 'monkey chain' for adequate mobility in bed.

There are, however, the more severe cases which require to be immobilized in a full plaster bed, and it is with this type of case that we propose to deal in detail. They may be classified into two principal types: (1) Fractures of the spine with lesions of the spinal cord; and (2) Tuberculosis of the spine and the sacro-iliac and hip joints.

These cases are immobilized for the most prolonged periods, usually in a plaster bed which is mounted on a wooden or other type of frame. Three

serious disadvantages of this form of treatment are at once apparent, namely: (*a*) The patient's view is limited to the ceiling or floor of the ward, and he 'vegetates' from sheer boredom. (*b*) Drainage of the renal pelves is poor, and there is a constant danger of the development of renal calculi. (*c*) The vasomotor system becomes so sluggish that the ultimate assumption of the upright position is associated with excruciating pain in the feet and legs.

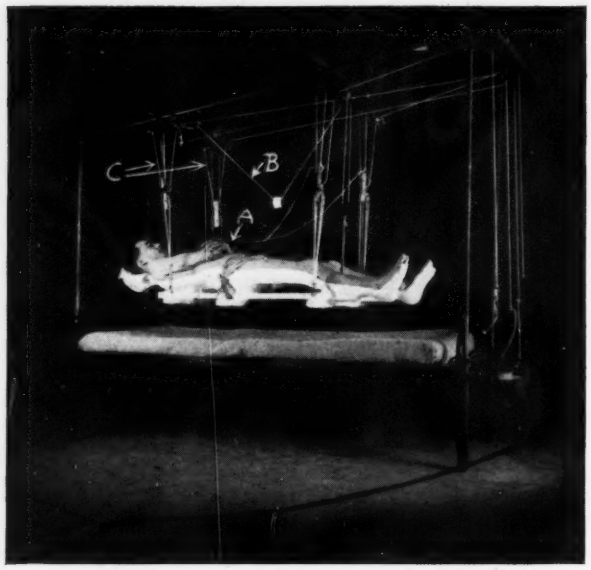

FIG. 553.—Tuberculosis of the lumbar spine treated in a plaster bed which is suspended. This form of suspension gives finger-tip control, and the patient is able to alter the position of the bed at will. The neutral or resting position is shown, and the patient is able to lower the bed on to the mattress.

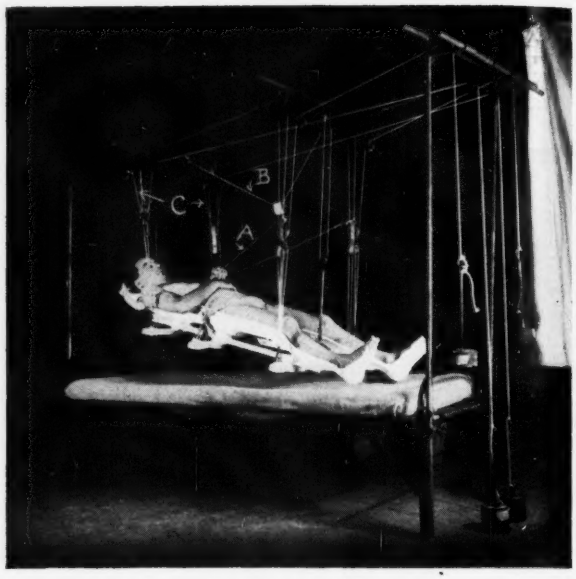

FIG. 554.—Case of tuberculosis of lumbar spine treated in a plaster bed. The patient has raised the head end of the bed. Traction on cord A lowers the foot end of the bed. Traction on cord B raises the foot end of the bed. Any desired position of the bed, once obtained, is maintained without further effort.

A method of treatment which minimizes the above three factors, without in any way interfering with the immobilization of the affected part, is therefore described below.

The standard posterior plaster bed or shell is used, with an anterior, turning bed or shell for use at regular intervals.

Wooden bars are incorporated in the undersurface of the plaster bed, two of them in a longitudinal direction to provide strength with a minimum of weight, and two in a transverse direction, at below-knee level and shoulder level, to furnish the necessary 'suspension points'. These bars are shown in *Figs.* 553–555, and their dimensions are:—

Longitudinal bars: Approximately 6 ft. × 2 in. × 1½ in.

Transverse bars: 2 ft. × 2 in. × 1½ in.

The principle of suspension is the same as that described above, but in order that maximum efficiency of the apparatus be obtained, the mechanical advantage of the pulley system is increased to four at shoulder level on both sides, while it remains at three at below-knee level.

This suspension allows the nursing staff to alter the position of the plaster bed with ease, while the addition of a further auxiliary system of pulleys enables the patient to perform these movements for himself.

The method is illustrated in the accompanying photographs, and the various positions of the plaster bed are shown. The apparatus appears complicated at first sight, owing to the number of cords and pulleys used, but it is emphasized that a single principle is applied throughout, and that the materials required are no more than the standard equipment with which many orthopædic units are supplied.

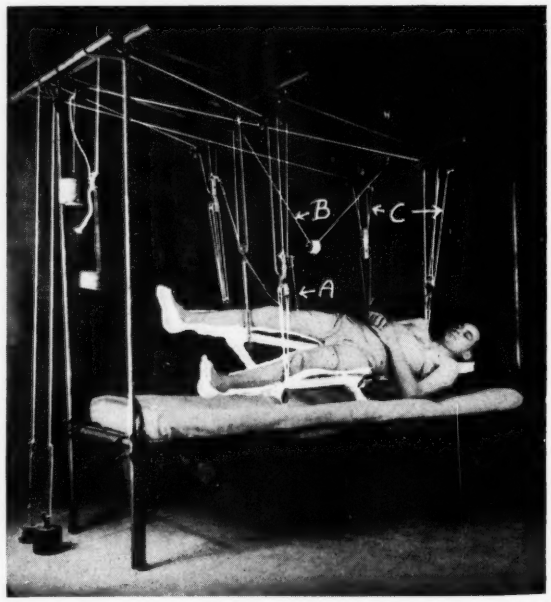

FIG. 555.—Tuberculosis of lumbar spine. Same case as in *Figs.* 553, 554. The patient has tilted the bed over to one side. This is done by manipulating cord C on that side between the thumb and forefinger. Manipulation of cord C on both sides at the same time will raise or lower the head end of the bed. The position shown promotes drainage of the renal pelvis and assists the patient during feeding.

Attention to detail is essential, and the weights are finely adjusted by the method of 'trial and error' until finger-tip control is provided for the patient.

The weights involved in the case of the patient shown in the illustrations were :—

Body-weight of patient	105 lb.
Weight of plaster cast	25 lb.
Total	130 lb.

Suspending weights :—

2 × 11 lb. at shoulder level, each with an M.A. of 4	88 lb.
2 × 7 lb. at below-knee level, with an M.A. of 3	42 lb.
Total	130 lb.

This plaster bed was so delicately adjusted that the addition or subtraction of a single blanket was sufficient to disturb the balance, but it gave the patient finger-tip control, and enabled him to adopt the various positions shown with absolute ease. He raised the head end of the bed for the purpose of reading, tilted it over to the side for eating and sleeping, and raised the foot merely for variety.

The effects on morale are considerable. The patient delights in the relative freedom of movement afforded him, and in the degree of independence he enjoys. He takes pride in the assistance he is able to give the nursing staff in the performance of their routine duties, such as arranging his bedclothes, administering bed-pans, etc., and he spends a good deal of his day in altering his position to suit his needs.

Arm exercises, renal drainage, and stimulation of the vasomotor system by alterations in posture are virtually automatic.

The anterior or turning shell is suspended in exactly the same manner as above, but in this case the auxiliary pulleys are dispensed with, for the patient raises or lowers the shell by merely grasping the bedstead.

Details of the apparatus are described and illustrated in *Figs.* 553–555 below.

Technique of Suspension.—In order to obtain maximum efficiency of the apparatus described above, attention to detail is essential, and the following points in technique require to be rigidly observed :—

1. Pulleys should be mechanically efficient, and should have a diameter of 1½–2 in.

2. Pulleys to be kept well oiled at all times.

3. Pulleys to act in their correct axes, without the imposition of any lateral strain.

4. Cords used in suspension to be of such a type as to offer the minimum of friction at the pulley wheels. Woven cord of the ' window sash ' variety is suitable, but twisted cord is inefficient and liable to fray and break as a result of the friction it causes. We have found steel cable, used in aircraft, to be best.

5. Twisting of the cord or cable is to be avoided during the assembly of the apparatus, for this adds considerably to the friction at the pulley wheels.

6. Weights for traction on fractured limbs must be of considerably less magnitude than those normally employed, in order to avoid distraction of the fragments. We found 11 lb. to be adequate in most fractures of the femur and 8–9 lb. in fractures of the tibia and fibula.

7. Wire loops incorporated in plaster casts must not encircle the part, but must be applied only to the upper half of the cast. This eliminates the danger of their cutting into the cast and causing pressure sores.

8. Balkan beams must be of sufficient strength to support the weight of the patient at least three times over, for the exercises which he is apt to perform impose a great strain on the beams.

ADVANTAGES OF THIS METHOD OF SUSPENSION

The initial object of this form of suspension was to mobilize the patient during the time that the affected part was immobilized.

This was achieved, but other advantages became apparent as treatment progressed, and in the case of fractures were such as substantially to reduce both the duration of treatment and of convalescence. The following were the outstanding features :—

1. The patient is afforded maximal mobility in bed, coupled with entire comfort. The psychological appeal of the apparatus is such that no encouragement is needed to perform vigorous, active exercises, and it is no exaggeration to state that many patients emerge from their treatment in a better general physical state than existed at the time of receipt of injury.

2. The effect on morale is entirely beneficial. The patient enjoys an unexpected degree of independence from the outset of the treatment. The result in battle casualties is a conspicuous absence of that ' wounded soldier ' complex which was so distressing a feature after the 1914–18 war.

3. The general health of the patient is enhanced by the strenuous exercises of all those muscles which are not immobilized,

4. Constipation, which can be so distressing to the patient who is compelled to remain in the supine position, is relieved by the effective abdominal contractions made possible.

5. Wasting of the muscles of the immobilized limb is minimized, and in several of our cases of femoral fracture we detected no wasting of the quadriceps group on ultimate removal of the Thomas splint or plaster cast.

The explanation of this phenomenon is probably that of Böhler, who emphasizes the value of the isometric, synergic contractions of the muscles of the immobilized limb, brought about by the active functioning of the muscles acting on joints which are not fixed.

6. The rate of union of fractures is accelerated. We attribute this to the absence or reduction of muscle wasting described above, for it is evident that the vascularity of a well-muscled limb is greater than that of a wasted one ; *ipso facto* the vascularity of the fracture site is proportionately greater.

7. Joint stiffness after prolonged immobilization is reduced, and this is most evident in cases of femoral fractures. It appears that an important factor in this reduction is the excellence of the musculature of the part, and that the muscles are able to overcome minor adhesions directly movement is permitted at the joint. We noted a range of 90° of movement at the knee-joint in a large proportion of our cases of femoral fractures, and a rapid increase in this range during the first month of convalescence.

8. Post-operative pulmonary congestion is avoided by the immediate activity of the patient, and this complication has not occurred in a single case where this form of suspension has been applied. Our youngest patient was 6 years and our oldest 78 years of age. The latter patient suffered from congestive cardiac failure on admission to hospital, and operation was deferred until this had resolved.

9. Nursing is made extremely easy, for the patient is able to lift himself while bedclothes are adjusted, bed-pans administered, etc.

One nursing sister is therefore able to administer to an entire ward in a short space of time, and to perform her routine duties without effort. This is a factor of considerable value in an orthopædic ward, which is usually the busiest ward in a hospital.

10. Pressure sores are prevented by the patient's own movements, and by the ease with which the nursing staff are able to attend to the skin at danger points.

11. Postural drainage of compound fractures is performed by the movements of the patient, and 'sumping' of pus, which is so frequent a complication of fractures of the distal half of the femur, has not occurred in a single case treated by these methods. Should it be necessary, however, to turn the patient on to his face for postural drainage, this is readily performed by unhooking the slings from the compound pulley, turning the patient, and then re-attaching the apparatus in reverse.

12. Vasomotor tone of the lower extremities is maintained by the frequent alterations in position of the patient. This is of particular value in cases of tuberculosis of the spine, which are treated in a plaster bed for months or even years, and who are wont to suffer severe causalgic pains in the legs when the upright position is finally resumed.

13. Postural drainage of the renal pelves is promoted, and the incidence of renal calculi in tuberculosis of the spine is minimized.

14. Effective elevation of an œdematous limb is permitted, and in the case of compound fracture of the tibia and fibula this may render possible the successful delayed primary suture of a hitherto unapposable wound. Early conversion of a compound fracture into a simple one is therefore facilitated.

In conclusion, there was no contra-indication to its use in our series of cases, and it was of value also in patients who did not have the use of their arms. By raising or lowering the suspending weights the nursing staff were able to alter the position of the patient with ease and thus attend to his wants and needs.

SUMMARY AND CONCLUSIONS

An improved method of balanced traction and suspension is described. The method is simple, and requires little more than is included in the standard equipment of orthopædic wards.

Its object is to afford the patient with a fracture or disease of the spine, pelvis, or lower extremities maximal mobility in bed, but it has several other advantages which are discussed.

It has been used in a large number of cases, and there has been no contra-indication to its use.

It is claimed for the method that it substantially increases the rate of union of fractures, and that it reduces the period of convalescence to a minimum.

Acknowledgements.—

Major-General W. C. Hartgill, C.B., O.B.E., M.C., K.H.S., D.M.S., A.F.H.Q., and

Brigadier W. H. du Plessis, O.B.E., D.G.M.S., S.A.M.C., for permission to publish this paper.

Colonel G. D. English, ex D.D.M.S., U.D.F., C.M.F., for his unfailing advice and encouragement.

Lieut.-Colonel R. H. Rose-Innes, S.A.M.C., for clinical advice.

S. A. Public Relations Film and Photographic Unit, U.D.F., C.M.F., for the clinical photographs.

Lieutenant E. Mitchell, S.A.I.C., U.D.F., C.M.F. for the diagrams.

A "R.E.M.E." Company, C.M.F., and No. 1 Air Depot., U.D.F., for the Balkan frames and the pulleys.

Major H. Witherspoon, R.E.M.E., and W.O.II (Miss) H. Cruikshank, W.A.A.S., for technical services.

The Nursing Staff who were members of the S.A. Orthopædic Unit in the C.M.F., at which this form of treatment was initiated, for their ever-willing services and their enthusiastic co-operation.

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THE SOLITARY ECTOPIC PELVIC KIDNEY

WITH REPORTS OF TWO FURTHER CASES

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IN a most comprehensive review of the literature of solitary ectopic pelvic kidney, A. R. Stevens (1937) collected only 27 cases between the years 1830 and 1937. It is significant, however, that with improved diagnostic facilities, and doubtless the stimulus of Stevens's paper, 15 more cases have been recorded in the last ten years, bringing the total by May, 1946, to 42. Therefore, although a solitary pelvic kidney is still a sufficiently rare anomaly to warrant publication, it probably occurs much more frequently than a reference to the literature would indicate. This fact is important, since apart from the 8 examples found at autopsy, the correct diagnosis was only established before, or without, operation

in 15 out of the remaining 34 cases, i.e., in only 44·4 per cent.

Previous papers on this subject state that the incidence of solitary pelvic kidney is much greater in females than in males, but this is not so, since in the 29 cases where the sex is recorded, the ratio is only 15 to 14 in favour of the female.

However, while only two of the male patients had associated genital anomalies, every one of the females recorded had some such lesion, and it cannot be stressed too often that the discovery of any serious genital defect, especially in the female, should be followed by a full urological investigation.

A review of the numerous clinical histories shows that very few of the patients presented themselves as urological cases. The commonest symptom was lower abdominal pain, the commonest physical sign was a palpable tumour, while surprisingly few of them had any urological symptoms at all, so that the anomaly is of equal interest to both the general surgeon and the urologist.

Many cases are undoubtedly overlooked, even after careful examination and/or laparotomy. Several of the published cases had been in hospital on previous occasions, while some had even undergone abdominal operations without revealing the true pathology. Appendicectomy was performed on at least three occasions, while the earlier reports show that the solitary kidney was removed twice, opened in mistake for the uterus once, and subjected to biopsy on another occasion. The mortality of the cases subjected to operation is very high, a point stressed by Lowsley (1944). The latter's own case is interesting in that he resected some 8 c.mm. of redundant ureter and reimplanted the remainder into the bladder, thus overcoming obstruction at the ureterovesical orifice. Wright (1945) performed a successful pyelocystotomy for a similar obstruction, while lithotomy has been performed on three occasions.

As a rule, the blood-supply of a pelvic kidney comes from the region of the bifurcation of the aorta, and very adequate descriptions of the embryology and anatomy of such ectopic organs have been given by Fortune (1927), Gruenwald (1939), Anson et al. (1942), and others, so that the purpose of this communication is merely to bring up to date the original tables of clinical data published by Stevens in 1937 and McCrea in 1942, and to record two further cases, one of which simulated acute appendicitis, while the other was complicated by a ureteric calculus. (*Table I.*)

Case 1.—W. H., aged 43, attended the out-patient department giving a history of dysuria and hæmaturia of one month's duration. He complained that the pain appeared to be more in the penis than in the region of the bladder and stated that recently he had experienced increased frequency of micturition at night. On rectal examination the prostate itself was normal, but at the upper limit of the prostate there could be palpated a tender pedunculated swelling on the right side of the pelvis.

He was admitted to hospital on Sept. 20, 1937, for investigation. Cystoscopy showed a slight inflammation present on the right side of the bladder, while a large pelvic swelling caused a bulge on the right side of the bladder, hiding the ureteric orifice from view. There was no evidence of a left ureteric orifice. Following injection of indigocarmine, secretion was noted after six and a half minutes coming up from behind the bulge in the bladder.

A plain radiograph showed no renal outlines, but there were several small dense opacities overlying the sacral area. Excretion urography (*Fig.* 556) showed no

FIG. 556.—*Case* 1. Excretion pyelogram showing calculus impacted at lower end of ureter.

evidence of any renal tissue in either loin, but a solitary pelvic kidney was demonstrated in the presacral region. The function was good, while the shadows previously seen were located in the calices and in the lower end of the short dilated ureter. The blood-urea was 49 mg./100 ml. and the urea concentration test was within normal limits.

Operation was carried out under spinal anæsthesia, and by a right paramedian incision and retroperitoneal approach the right kidney was found on the posterior wall of the pelvis. The ureter was extremely short and contained a mulberry-shaped stone about ½ in. proximal to the bladder wall. This stone was removed. Both the ureter and kidney were covered with a mesh of blood-vessels, and no main renal artery could be seen or palpated.

No attempt was made to remove the renal stones as it was felt that the viability of the kidney might be impaired by interfering with its vascular supply. The ureter was closed, and the abdominal wound closed with a tube down to the ureter.

His convalescence was normal, apart from the fact that he complained of pain in the right groin. The wound healed satisfactorily, and he was discharged six weeks after operation.

Table I.—Cases of Solitary Ectopic Pelvic Kidney reported in the Literature.
A Continuation of the Data given by Stevens (1937) and McCrea (1942)

Case No.	Author	Year	Age	Sex	Anomalies Noted (Genitals, Etc.)	Clinical Diagnosis	Urological Findings	Operation	Result	Blood-supply
1	Henot	1830	8 mth.		All genitalia absent. Sex indefinite		Autopsy			
2	Merrier	1854	47 yr.			Carcinoma of left hypochondrium	Pelvic rounded kidney	Autopsy		
3	Watson, M.	1864				Pathological specimen only		Autopsy		Left renal artery from bifurcation of aorta; divided into two, entered upper pole of pelvic kidney
4	Hebb, R. G.	1885	6 yr.				Dilated single ureter. Kidney almost normal	Autopsy		Three arteries from aorta above bifurcation. Two from internal iliac. Vein from upper half of kidney to internal iliac; from lower half to common iliac
5	Guelmi, A., and Ciniselli, G.	1887	10 yr.	F.	Uterus, broad ligament and ovary at 12th dorsal vertebra; vagina absent		Ureter dilated. Kidney elliptical	Autopsy	Died of uræmia due to parenchymatous nephritis	
6	Strube, G.	1894	1 mth.	M.	Anovesical atresia		Right solitary pelvic kidney of irregular shape	For atresia	Died 1 month after operation	Three renal arteries (1 right; 2 left). Two from left common iliac artery
7	Barlier and Broussole	1895								
8	Chretien	1895					Dilated ureter	Autopsy		
9	Buss	1899	21 yr.	F.	Vagina absent. Fibromata in ovaries	Ovarian tumour		Removal of tumour and kidney	Died of anuria	
10	Winter, G. J.	1905	21 yr.			Abdominal tumour		Extirpation of kidney	Died of anuria	
11	Cullen, T. S.	1910	17 yr.	F.	Vagina absent. Both tubes and ovaries in inguinal canals			Exploration operation		
12	Cutore, G. (cited by Tachot)	1910		F.	Vagina and uterus absent. Tubes and ovaries rudimentary		Kidney contained a calculus. Dilated ureter			
13	Gaitschmann, V. I.	1910	30 yr.	F.	Uterus bicornuate	Abdominal tumour		Exploration		
14	Rolleston, I. D.	1916	14 yr.	M.	Mentally defective		Dilated pelvis and calices. Dilated ureter	Autopsy	Died of scarlet fever	
16	Judd, E. S., and Harrington, S. W.	1919			Malformation of liver and duodenum	Ovarian cyst		Laparotomy		
17	Judd, E. S., and Harrington, S. W.	1919								
18	Day, R. V.	1924	20 yr.	F.	Vagina, uterus, left tube, and ovary absent		Only one ureteral orifice	Laparotomy; opened kidney for uterus	Living	
19	Roeder, C. A.	1925		F.	Vagina, uterus, and left adnexa absent			Laparotomy, appendicectomy		"Kidney pelvis posterior to renal vessels pointing up and
20	Bitschal, J.	1925	20 yr.	F.	Vagina absent		Only one ureteral orifice	No operation (clinical report)	Living	
						Appendicitis		No operation	Living	

19	Bitschal, J.	1925	20 yr.	F.	Vagina absent		Only one ureteral orifice	No operation (clinical report)	Living	
20	Bratrud, E.	1929	48 yr.	M.		Appendicitis		No operation	Living	
21	Hennessey, R. A.	1929	19 yr.	F.	Never menstruated		Only one ureteral orifice; pyonephrosis	No operation	Died	One renal artery from bifurcation of aorta. One renal vein enters bifurcation of vena cava
22	Tachot	1931	44 yr.	F.	Vagina absent. Never menstruated	Renal calculus	Hydronephrosis with calculus	Transperitoneal lithotomy through kidney cortex	Urinary fistula. Died 3 yr. later of uræmia	No note of blood-vessels
23	Guiterrez, R.	1933	32 yr.	F.	Hypothyroid. Never menstruated. Genital anomalies		Diagnosis by retrograde and intravenous pyelogram	No operation. Renal lavage only		
24	Nesbit, R. M.	1935	8 yr.	M.		Urinary retention	Large abdominal mass. (Hydronephrosis —1500 c.c.)	Nephrostomy	Living 9 years later	
25	Shpirt, M. Y., and Spektorova, Z. G.	1935			No information available					
26	Stevens, A. R.	1936	31 yr.	F.	Rudimentary vagina	Abdominal and pelvic mass	Right ureteral ridge and orifice only. Pyelogram	No operation	Living	
27	Stevens, A. R.	1936	30 yr.	M.	No abnormalities	Calculi in pelvic kidney	Right ureteral ridge and orifice only. Retrograde and intravenous pyelograms	Lithotomy	Living and well 8 months later	
28	Kuzmenko, L. N.	1936			No information available					
29	Houtappel, H. C. E. M.	1937	68 yr.	M.	No abnormalities	Calculus ureteropelvic junction		Lithotomy	Died 5 days after operation	
30	Mayers, M. M.	1940	33 yr.	M.	No abnormalities	Pelvic kidney	Diagnosis by retrograde and intravenous pyelography	No operation		
31	Ogden, H. C., and Maltry, E.	1940	17 yr.	F.	Uterus, tubes, and vagina absent; ovaries displaced		Single left ureter	Exploratory	Living	
32	Ockerblad, N. F., and Carlson, H. E.	1940	36 yr.	F.	Left tube and ovary congenitally absent. Uterus oblong, pear-shape; shift to right	Solitary pelvic kidney	Diagnosis of solitary pelvic kidney made 6 years before by intravenous and retrograde method	No operation	Died, renal failure, 6 years after diagnosis was established	
33	Planes, A., and Fablet, F. J.	1940			No information available					
34	McCrea, L. E.	1942	33 yr.	M.	Undescended right testicle; epididymis lying in mesentery of cæcum		Single right ureter	Autopsy	Died of uræmia	One artery at bifurcation of aorta; one artery from left common iliac
35	Goldberg, H., and Fowler, H. A.	1942	51 yr.	M.	No abnormalities		No left ureteric orifice seen. Excretion and retrograde pyelograms. Good drainage and function	No operation		
36	Weinstock, H. L., and Keesal, S.	1943	22 yr.	M.	No abnormalities	Renal tumour suspected, owing to profuse hæmaturia	No left ureteric orifice. Excretion and retrograde pyelograms. Tubercle bacilli isolated from urine	No operation		
37	Lowsley, O. S., and Henning, J. H.	1944	7½ yr.	M.	Undescended testicles. No operative information		Ill-defined left half of trigone with no ureteric orifice. Retrograde pyelogram showed poor drainage	Nephropexy and excision of 8 cm. of redundant ureter with re-implantation to bladder	Alive and well 15 months after operation	

Table I.—CASES OF SOLITARY ECTOPIC PELVIC KIDNEY—*continued*

CASE No.	AUTHOR	YEAR	AGE	SEX	ANOMALIES NOTED (GENITALS, ETC.)	CLINICAL DIAGNOSIS	UROLOGICAL FINDINGS	OPERATION	RESULT	BLOOD-SUPPLY
39	Nichols, B. H., and Marr, J. T.	1945	20 yr.	F.	Uterus and tubes absent. Ovaries not identified. Normal but short vagina with no cervix	Pelvic kidney thought to be uterus	Excretion pyelogram showed no evidence of any left-sided renal mass. Right kidney ectopic	Laparotomy		
40	Wright, B. W.	1945	42 yr.	M.	Congenital deformed fingers. Absent right testicle	Hydronephrosis in solitary pelvic kidney	Excretion pyelogram showed no renal shadows and only a poor concentration of medium in bladder. Two normal ureteric orifices seen. No dye excretion from either orifice. Right blind ureter 3 cm. long. Left retrograde pyelogram performed	Pyelocystotomy performed	Alive and well 10 months after operation	From aorta round bifurcation
41	Zucker, M. O.	1946	24 yr.	M.	No other congenital abnormality		Excretion pyelograms. Absent inter-ureteric ridge. No left orifice	No operation		
42	Goodhope, C. D.	1946	57 yr.	M.	No abnormality	Prostatic obstruction	Prostatic obstruction. Excretion pyelogram: absent right kidney and pelvic left kidney. Right half of trigone absent	Attempted endoscopic resection. Suprapubic cystotomy	Died	
43	Hanley, H. G., and Steel, W. A.	1947	43 yr.	M.	No abnormalities	Solitary pelvic kidney, ureteric stone	Excretion and retrograde pyelograms	Uretero-lithotomy	Alive and well a year later	From aorta round bifurcation
44	Hanley, H. G., and Steel, W. A.	1947	9 yr.	F.	Absence of vagina, uterus, and tubes. Complete transposition of thoracic and abdominal viscera	Acute appendicitis with pelvic peritonitis	Excretion and retrograde pyelograms. Right half of trigone and ureteric orifice absent	Laparotomy	Alive and well 9 months later	Aorta and left common iliac artery

He was later seen in the out-patient department. the six months following his operation he passed n minute calculi. When last seen he was symptom fr Excretion urography on June 3, 1938, showed: "Rat delayed excretion. Kidney still seen in presacral regi Not so dilated as previously. No calculi seen."

Case 2.—A nine-year-old girl was admitted to hospi with a history of two days' abdominal pain and attack of vomiting.

Examination revealed a flushed, but otherwise healt looking, child complaining of lower abdominal p which had been colicky and intermittent, but was n dull and constant. Her temperature was 100·2° pulse-rate 120, while her tongue was slightly furred a she had not had a bowel action for 48 hours.

Both thighs were held slightly flexed for comfort, b she made no protest when they were passively extende Her lower abdomen was markedly rigid and tender palpation, while she indicated the site of maximum p by placing her finger about three finger-breadths abo the symphysis and to the right of the midline. Bo loins were free from pain or tenderness and she deni any micturition symptoms. She had not yet started menstruate.

Rectal examination revealed hard fæces and a vag mass high up in the pelvis which was too tender define.

It was decided to operate upon the child as a case acute appendicitis with pelvic peritonitis. During t routine examination of her chest a dextrocardia w discovered, but there was still no reason to doubt t diagnosis. Laparotomy was performed under ga oxygen, and ether anæsthesia (administered by D T. E. D. Beavan) when the true anatomical dispositi became apparent. There was no free fluid. T cæcum and a normal appendix were lying in the left ili fossa, there being complete transposition of all viscer while a large renal mass was lying over the right side of t sacrum, no kidneys being palpable in either renal foss There was no evidence of vagina, uterus, or Fallopi tubes, but two small masses palpable at about t site of the internal inguinal rings were assumed to b ovaries.

The renal mass was lying obliquely over the sacr region and there appeared to be at least three separa pulsating vessels arising from the area of the bifurcati of the aorta and the left common iliac artery. Th kidney had less than half an inch of mobility in an direction.

The normal appendix was removed and the abdom closed. Following the diagnosis of pyelitis in a solita ectopic pelvic kidney, sulphathiazole was administere and a catheter specimen of urine two days later reveale a few colonies of coliform bacilli with a few pus cells in th centrifuged deposit.

The subsequent convalescence was uneventful unt the fifteenth day, when she developed chicken-pox. As consequence of this, a full investigation was not carrie out for another six weeks. By this time the child wa symptomless and it was now just possible to feel th renal mass suprapubically, and quite easily per rectum.

Chest radiographs confirmed the dextrocardia, an a barium meal and follow-through confirmed the abdo minal transposition. Excretion pyelograms showed normally functioning ectopic pelvic kidney, but n loin shadows (*Fig.* 557).

Cystoscopy revealed the absence of the right urete and right half of the trigone, there being no inter-ureter bar. A retrograde pyelogram was performed withou difficulty (*Fig.* 558). The blood-urea was 25 mg./100 c and the blood-pressure 115/80.

The child is alive and well now nine months later, bu the urine still contains a few coliform bacilli and pu cells in spite of chemotherapy.

SUMMARY

A solitary pelvic ectopic kidney is probably not such a rare occurrence as was previously thought. Its importance lies in the fact that the symptoms and signs do not generally indicate urological pathology, so that the correct diagnosis may only be made by a process of exclusion.

The incidence is probably equal in both sexes, but it cannot be too strongly emphasized that the discovery of any congenital lesion in the genital tract of the female should be followed by a full urological investigation. Every solitary ectopic kidney in a female so far reported has had an associated genital anomaly.

Two further cases are added to the world literature, bringing the total to 44.

Since this paper was presented for publication in November, 1946, it has been found that two more cases have been described :—

a. Howard B. Mays's case (1946).—Male, aged 29, no genital abnormalities. Pelvic mass diagnosed as appendix abscess. Laparotomy. Intravenous pyelogram : absent left kidney. Normal function of right pelvic kidney. Absent left half of trigone.

b. Schreiber and Smith's case (1946).—Ectopic left pelvic kidney. Absent vagina and uterus.

FIG. 557.—*Case* 2. Excretion pyelogram.

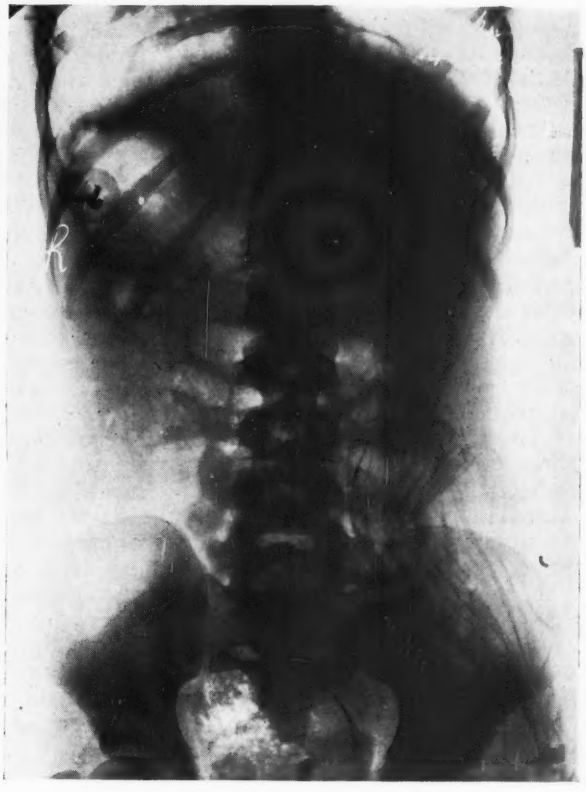

FIG. 558.—*Case* 2. Retrograde pyelogram.

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A SURVEY OF THE INCIDENCE OF INGUINAL HERNIA IN DIFFERENT RACIAL GROUPS

By A. IAN L. MAITLAND

THE projected regionalization of the hospital services throughout the country requires a knowledge of the prevalence of the commoner ailments in the general population if the assessment of the needs of each district is to be accurate. In this connexion, conscription for service in the armed forces offers an opportunity to inquire into the incidence of disabilities and disease in young adults. A survey of the records of a general hospital in an industrial area proves that inguinal hernia is a common cause of disability in the general population. In the Western Infirmary, Glasgow, during the years 1941, 1942, and 1943 this condition provided 4·64 per cent of the average annual totals of surgical admissions apart from orthopædic cases, only being exceeded in frequency by acute appendicitis.

In this article the apparent incidence of hernia noted on investigation in a group of young adult males is discussed and related to the incidence disclosed in similar but smaller groups drawn from Allied countries. The investigation was carried out on personnel passing through a New Entry Establishment into the Royal Navy during twelve consecutive months. During the same period there were present in the Establishment comparable age groups drawn from three Allied countries. The opportunity thus afforded was taken to enlarge the investigation to cover these groups, which were drawn from Norwegian, Dutch, and Belgian personnel, as in all but one of the groups the medical standards applied prior to arrival were considered for practical purposes to be comparable.

British personnel passing through during the period consisted of new entries and ratings transferred from other establishments and training depots for re-categorization. For the purpose of this investigation only the new entries direct from civilian life have been considered. These had all been examined by civilian medical boards, and, on the standard applicable to such examinations, the discovery of a hernia did not bar the individual from service, but lowered his physical grade until repair had been effected. They were re-examined on arrival and men with scrotal abnormalities or scars referred to the surgical specialist. The personnel of the other national groups had all been examined prior to arrival. The Dutch group were examined in Holland or in London and by their own medical officers on joining the establishment. The Belgians had been examined either in London or before they left Belgium and were passed into the establishment by British medical officers. In the Norwegian group the medical examination was done in London but was not repeated as a routine on arrival. Most of this group came through Sweden and previous selection to a very high medical standard had probably occurred at that stage in their journey. The standard requirements in relation to hernia did not differ between groups or from those governing entry into the Royal Navy, and it was felt that with the exception of the Norwegian group it was reasonable to assume that previous selection of a medical nature had little if any influence on the figures which subsequently emerged for each group.

The criteria required for inclusion as inguinal hernia were: uncomplicated inguinal hernia, herniotomy scars, recurrent hernia, and hernia proved by operation as a complication of maldescent of the testis. Fusiform thickening of the cord in the canal, pain in the groin on exercise, and weakness of the posterior wall of the canal in subjects of lax musculature, were for simplification considered together under the heading 'weak canal'. It will thus be evident that the net was cast as widely as possible, and as the number of individuals who failed to disclose a scar or small hernia at the examination must have been small, the figures obtained can be regarded as reasonably accurate.

The largest group examined consisted of 20,454 recruits to the Royal Navy, almost all of whom were between the ages of 17 and 20 years. Since hernia is not a bar to acceptance for the service but must be repaired on entry, the incidence disclosed (5·36/1000) may be taken as representative for that section of the male population. It is of interest to record that the three cases classed as miscellaneous hernia were: a symptomless diaphragmatic hernia apparently through a large opening in the posterior half of the left crus—first picked up by the radiologist on the miniature film of the pulmograph; an umbilical hernia; and an epigastric hernia.

The Royal Norwegian Naval Contingent was drawn from a wider age group than the British new entries, but consisted mainly of men under 25 years of age. During the twelve months under review just over 800 Norwegians passed through the establishment, and from this number only one case of pain in the groin was seen, although the course of training undertaken by this group was extremely severe. As a search of the records over eighteen months revealed only one herniotomy on a Norwegian rating, the total number passed through the Establishment in five years (2853) has been included. The incidence (2·8) is remarkably low and, as already noted, is regarded as probably due to previous selection to a high physical standard.

The Royal Netherlands Naval contingent totalled 2451 during the period, and consisted of two groups. One, the larger, was composed of young volunteers from liberated Holland; the other, much smaller, comprised returned prisoners of war who were, on the average, older. Their inclusion in the group, if it affects the figures at all, tends to lower the incidence (8·12). The factor common to both groups was that diet had been insufficient and exercise of a healthful nature reduced to a minimum during the period of the occupation. These men were examined medically before leaving Holland, and it is possible that a number of herniæ were picked up there and did not reach Britain. Apart

from this possibility the incidence is relatively high, and, as will be shown later, is of particular interest.

The Section Belge in the Establishment recruited during the period 1350 new entries. They were all volunteers about 20 years of age, with a high average standard of education, who came over from Belgium after the liberation of the country. During the period of occupation conditions had been similar to those in Holland, except that the food situation—for these men at least—did not appear to have been so bad. The incidence (5·92) falls between that of the Dutch and British groups.

In *Table I* the numbers are arranged under wide headings, and in each group the incidence given is for inguinal hernia of all types. Incisional hernia has not been included. A study of this table shows

Table I

Group	Inguinal Hernia	Femoral Hernia	Miscellaneous	Total	Incidence Per 1000 Inguinal Hernia
British new entries, 20,454	110	1	3	114	5·36
Norwegian, 1940–45, 2853	8	—	—	8	2·8
Dutch new entries, 2461	20	—	—	20	8·12
Belgian new entries, 1350	8	1	—	9	5·92

that if these four groups are accepted as reasonably comparable, the divergencies displayed between them are not significant of themselves, but merely show tendencies in the groups as so far examined. When the groups are scrutinized more intimately and the figures for inguinal hernia dissected into their components, some further comparisons can be made. In *Table II* the results of this dissection are tabulated, and an examination of it reveals some interesting data.

personnel; among whom there were observed as well, 3 cases of hydrocele of the cord which do not figure in the table.

The other information which emerges is the behaviour of the figures for uncomplicated inguinal hernia and those for direct hernia. An examination of the former shows that while the incidence for the British, Belgian, and Norwegian groups remains relatively the same at 2·35, 3·1, and 1·4 per 1000 respectively, that of the Dutch group drops sharply to 2·1. A survey of the latter shows, on the other hand, that direct hernia was not observed in British or Norwegian ratings, was noticed in 1 instance in the Belgian group, but was relatively frequent in the Dutch. When the figures for direct hernia are combined with those of 'weak canal' the difference between the groups is even more marked. This is done in *Table III*.

Table III

Group	Direct Hernia	Weak Canal	Total	Incidence per 1000
British, 20,454	—	10	10	·488
Norwegian, 2853	—	3	3	1·051
Belgian, 1350	1	1	2	1·481
Dutch, 2461	7	7	14	5·688

It is felt that the difference in incidence for this combination between the Dutch and the other groups as shown in this table, is a significant one on the figures alone, but there is a further disparity between them which is not so readily apparent.

In the British and Norwegian groups, the 13 cases regarded as having weak rings were, with two exceptions (both British), men who complained of pain on exercise, or had a fusiform thickening of the cord within the canal which would in time become an oblique hernia if it developed at all. The two exceptions showed laxity and slight bulging of the posterior wall of the canal on both sides, not sufficiently marked to be regarded as a direct hernia.

Table II

Group	Oblique Inguinal Hernia	Maldescent of the Testis and Inguinal Hernia	Double Hernia Oblique and Direct	Recurrent Hernia	Direct Hernia	Weak Canal	Previous Operation	Total
British, 20,454	67	21	4	1	—	10	7	110
Norwegian, 2853	4	—	—	—	—	6	1	8
Dutch, 2461	5	—	1 Direct	1	6	7	—	20
Belgian, 1350	4	—	1 Direct	—	—	1	2	8

The most striking difference which appears is the presence in the British group of 21 cases of maldescent of the testis associated with oblique inguinal hernia proved at operation. This combination does not appear in any other group. It is of interest to note in passing, that, in the period reviewed, 49 cases of maldescent of the testis were examined; of this number, 28 were submitted to operation as an associated hernia was suspected, confirmation being obtained in 21 cases. All the cases of maldescent of the testis examined occurred in British

The single Belgian rating and all the Dutch ratings with 'weak canals' had more advanced bilateral bulging of the posterior walls, which was practically indistinguishable from direct hernia, but disappeared with the return to a generous diet and graded remedial exercises.

DISCUSSION

The scant attention which the incidence of inguinal hernia in the population has attracted in the past is surprising, since it is the cause of so much

loss in economic efficiency in manual workers. In 1884 Berger, as a result of a survey of 10,000 hernias in France, estimated the frequency to be 1 to 14·9 in the male population, i.e., 62·8 per 1000. In 1936 Armentrout, in America, reported 1837 hernias in 37,472 examinations of working men, making an incidence of 49·5 per 1000. No reference to hernia could be found in either the British or American official medical histories of the Great War of 1914–18. During the lately-concluded hostilities there have been two references to date. Edwards, in 1943, gives the figure of 143 cases occurring among 1300 recruits to the Army from the 35–36 age group. These figures give the very high incidence of 110 per 1000, which suggests that they may be drawn from a group of low medical category. The tables published in the recent report of the Chief Medical Officer to the Ministry of Health (1946) show remarkably little variation in the different age groups of service patients and only a slight difference in the mean incidence for the age groups covering from 15 to 55 years between the years displayed. (64·5 per 1000 in 1942; 59·25 per 1000 in 1943.)

Hernia is more common in arduous occupations and no comparison is satisfactory unless the occupational factor is considered. The British series in this paper is drawn from young adult males in unreserved occupations, and it is possible that the reservation from conscription of the heavier industries may have affected the figures to some extent. Part, at least, of the wide variation between the figures for this series and the others quoted may be explained in this way; but as they bear a reasonable relationship to the figures from the other National groups in the survey, it seems unlikely that the inclusion of the industries excluded from conscription would raise the incidence by ten times. It is, however, possible that imponderable factors have had a greater influence on them than is apparent. The physical standards of the Royal Navy are known to be high, and among the citizens of a maritime nation it is general knowledge that a hernia is not a good thing to take to sea.

Consideration on these lines may have diverted an unknown number of the ruptured into the other Services and so lowered the figures obtainable by a survey of this nature by an incalculable amount. These figures are undoubtedly to the low side, but it is felt that when an accurate estimate of the incidence of hernia in the general population is available it will be found that the other figures quoted are too high.

The causes underlying the tendencies displayed by the national groups are interesting, but in the absence of further study must remain obscure. The occurrence of maldescent of the testis seems unlikely to have become an exclusive privilege of the British. If this is so, it sets a pretty problem for the student of heredity.

The variations may be explained in some measure by the differing impact of occupation on the nationals of the countries concerned. Sir Astley Cooper (1827), in his excellent treatise on hernia, lists among the causes: the combination of fluid food of poor quality and hard work, debility, and the rapid loss of weight in the obese. These are precisely the conditions which prevailed in the occupied countries for over four years. During the war of 1914–18 a 25 per cent increase in hernia due to lack of food was reported in Germany (Watson, 1938), and two papers were published in 1944 (Braine and Rudler; Giraud), the titles of which suggest that the same cause has produced an increase in hernia in France during the privations of the recent occupation. Unfortunately, these articles are not available for scrutiny in this country.

In Malta the prevalence of hernia was noted by Astley Cooper over a century ago and is still remarkable. During the recent siege there was an increase in hospital admissions for this condition, but Professor Debono (1946) ascribes this to living conditions in general and not to the diet alone, as the latter, although very restricted, rarely caused more than the loss of superficial fat. The factor responsible for the relatively high incidence of 'weak canal' and direct hernia in the Dutch is perhaps the heavy impact of the enemy occupations noted in Holland by Bulmer (1945). He states as his opinion that, apart from the occupants of concentration camps, the Dutch suffered a more severe restriction in diet than any other country in Western Europe.

I am indebted to the Medical Director-General of the Royal Navy for permission to publish this paper and to the Consultant in Medical Statistics, Royal Navy, for helpful suggestions during the preparation of it. My thanks are due to my colleagues in H.M.S. *Royal Arthur* for their assistance during the survey period. I must specially acknowledge the willing help and co-operation of the authorities in charge of the detachments of the Royal Netherlands Navy, the Royal Norwegian Navy, and the Section Belge during this time. Without their assistance much of the work would have been impossible. Lastly, I have to thank the Medical Superintendent, the Western Infirmary, Glasgow, for permission to use the records.

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BONE ABSCESS FROM HUMAN BITE

REPORT OF A CASE

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THE case recorded here is of interest as an instance of a bone abscess arising from a human bite. A search of the literature has not revealed another report of a similar case. In fact, it is notable that although before this last World War there were a number of cases published of human bite infections of soft tissue, since the beginning of this most vicious of all wars, in which the fiercest and most brutal hand-to-hand fighting has played a large part, no human bite infections seem to have been reported.

There are other points of interest which are noted in the course of discussion.

CASE REPORT

Lieut. A. L. S., aged 21 years

July, 1943 : Bitten at the base of the right index finger by an enemy soldier in a hand-to-hand struggle during a commando raid. On return to his Base he was admitted to hospital with a swollen and badly infected hand. The bite was deep and the doctor told him at the time that the bone was bared and the soft parts badly torn. Hospital stay lasted fourteen days, but the hand was dressed for the last time two weeks after discharge as an in-patient. The wound healed well and function returned except full flexion at the metacarpophalangeal joint of the index finger, which was hindered by slight swelling over the palmar aspect of the metacarpal head. At times this became mildly painful and sometimes tender. He could not remember there ever being any colour changes or increase in size at these painful times. He proceeded on three weeks' leave as soon as the wound was closed, but was recalled after five days to rejoin for special training.

About the middle of August pain recommenced at the site of the wound and became severe. The part began to swell towards the end of the day, especially over the dorsum of the second metacarpal in the upper half. The patient continued at duty in spite of the pain, but by Sept. 2 found work impossible because the swelling no longer receded at night, pain was constant, and the part was red and glossy. On examination the points which had attracted the patient's attention were confirmed; and in addition œdema of the whole of the dorsum of the hand was noted, most marked over the second metacarpal head. There appeared to be a small collection of pus forming and making its way surfacewards at a point 1 cm. below the head of the metacarpal on the radio-palmar aspect. This aspect of the bone was exquisitely tender over its upper half. The patient's temperature was recorded as 101° F., pulse 100, respirations 20; general signs of toxæmia were present; a white blood-count showed a leucocytosis of 17,000, with 88 per cent polynuclears. The junior surgeon on duty incised the abscess, immobilized the hand in a posterior cast in flexion, and applied desiccated magnesium sulphate powder. Four days later the wound was clean and healing, the plaster cast was completed, and the patient allowed back to light duty.

On Sept. 21 the wound was healed, and apart from tenderness over the site of the recent abscess all appeared to be in order. Function of the index was fair; exercises were prescribed. The laboratory report on the pus from the finger showed that the predominating organisms were hæmolytic staphylococci and large fusiform bacilli of the type found in Vincent infections. At this time nothing more was suspected than a residual abscess of the soft parts from infection carried in with the bite.

By Nov. 7 the patient was back in hospital with a more diffuse swelling of the same region. The part was not so tender as before, but he complained that it ached more than the last time and kept him awake at night. No fluctuation or area of softening could be made out in the general and relatively firm œdema over the part. The temperature and pulse were within the limits of normal and the white count registered only 9000, with 75 per cent polynuclear cells. A radiograph (*Fig.* 559) showed two

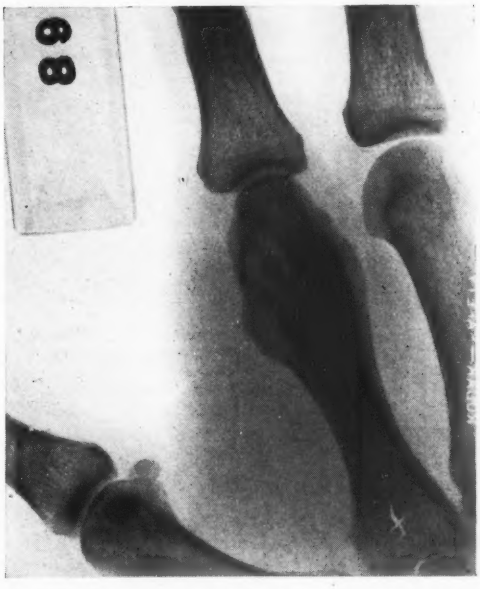


FIG. 559.—Radiograph showing two abscesses in the head of the second metacarpal immediately prior to operation.

clear areas in the head of the bone towards the palmar aspect of its radial border, and corresponding to the clinically inflamed part. Considerable periosteal reaction was evident, but the joint space was clear of trouble. It was now apparent that there had been a bone abscess in formation for some time and that the small abscess draining superficially had been merely a throw-off from this or a small latent focus of infection lit up by its proximity to the forming deep bone abscess. In view of the extensive œdema around the part, the hand was again put in plaster in an effort to rest and settle the inflammation before attempting to expose the abscess. The area being small and in consequence the eventual exposure that might be obtained a limited one, it was felt that the œdema and inflammatory side-effects present at the time of operation should be minimal. The patient was much relieved by the plaster and the hand quietened down considerably.

On Jan. 24, 1944, a radiograph showed the bone condition to be the same, and clinical examination revealed the œdema to be much less; deep tenderness was present over the upper half of the bone; and the total white count was found to have increased to 12,000. It was decided that the time had come for the bone abscess to be evacuated.

OPERATION (Jan. 28).—

Preparation.—For the two days prior to operation 4 g. of sulphonamide were given daily. The hand was

bathed daily with soap and hot water, dried, and protected with a sterile towel. On the morning of Jan. 28, one hour before operation, the hand was given a last bath, dried, put into a sterile white cotton glove, and the whole wrapped in two sterile towels. Morphine hydrochloride, 1 gr., with hyoscine hydrobromide, $\frac{1}{100}$ gr., was given 45 minutes before the scheduled time and a pneumatic tourniquet placed in position ready for inflation. In the theatre the table for the hand had been arranged with an empty X-ray film box, the opening of which was away from the side where the surgeon would be working, so that a charged casette could be easily inserted, withdrawn, and replaced if necessary during the operation.

FIG. 560.—Radiograph of the hand taken at operation and before closure of the wound, confirming clearance of both abscesses and an intact joint above.

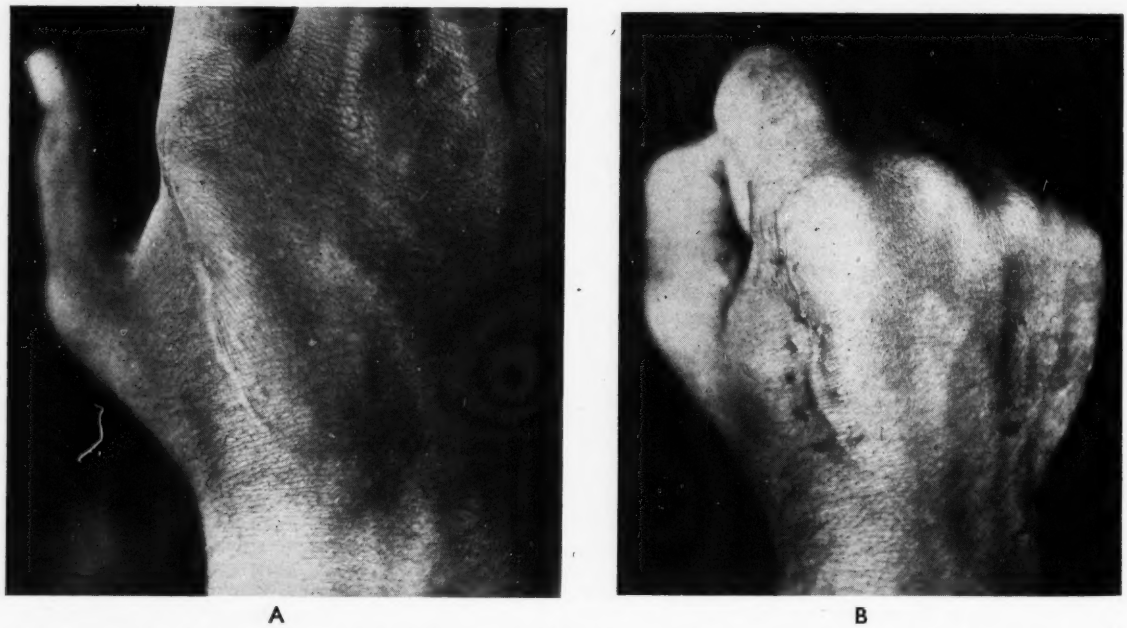
Over the box a portion of a wooden sphere, 12 in. in diameter and 2 in. deep at the centre, was set. After elevation of the hand and adjustment of the tourniquet at correct pressure, the hand was spread over a sterile towel on the convex surface of the wooden support to give it a mild curve and stability. Adhesive tape over the fingers, together with another piece over the thumb, and both brought under the wooden stand, fixed the hand securely in position. The cotton glove was then painted liberally with mastisol. The arrangement of the towels was such that a narrow-folded one came under the palm and out over the thumb. Four towels were set in the usual square manner over the dorsum of the hand to isolate the area for operation.

Anæsthesia.—Brachial plexus block anæsthesia was induced for me by Dr. Victor Goldman.

Exposure.—An incision was made extending along the radial border of the dorsal aspect of the 2nd metacarpal from 1 cm. above the metacarpophalangeal joint to the same distance proximal to the base of the bone. The incision was placed over the muscular belly of the first dorsal interosseus and made slightly convex towards pollex to avoid subcutaneous nerves and the subcutaneous border of the bone. A few small veins exposed lying in the upper fatty layer of the superficial fascia were tied and divided. The deeper and definitely fascial layer of the superficial fascia was next incised in the line of the skin incision. A small transverse connecting artery from the second interosseus to the first was found, ligatured, and divided. The skin, with these two layers attached, forming the ulnar flap, was dissected up until the bone of the second metacarpal and the tendons of extensor communis digitorum and extensor indicis could be distinctly seen below the true deep fascia.

The deep fascial layer splits into two layers to enclose the extensor tendons at the radial edge of the extensor communis tendon to index. By gentle manipulation the limit of this fascial space can be defined and the incision through the deep fascia so placed that the compartment containing the tendons is left intact.

In well-developed hands the deep layer of fascia can be incised apart from the delicate investing layer over the interosseus muscle below it. The incision was carried down to bone through periosteum near the radial



A B

FIG. 561.—The clinical appearance of the hand ten weeks after operation. A, Extension; B, Flexion—slight limitation.

edge of the bony plateau forming the dorsum of the metacarpal.

A small elevator was now introduced at the upper limit of the periosteal incision, just below the fibres of the joint capsule, and worked down towards the base, stripping that part of the first dorsal interosseus muscle from the bone. The elevator should be worked from head to base smoothly, exposure of the palmar surface being obtained by a series of such stripping actions—each at a more palmar (deeper) level than the last—until sufficient bone has been uncovered.

The radial flap consisting of skin, superficial fascia (with the veins, nerves, and first dorsal interosseus artery), deep fascia, investing layer, and muscle with attached periosteum, was then retracted easily to give a good view of the radial and palmar aspects of the affected metacarpal.

The periosteum over this end of the metacarpal was thick, œdematous, and peeled easily to uncover a layer of new bone, ribbed and pitted in characteristic manner. A trough was started with a fine mastoid gouge working towards the head of the bone and following the main mass of the new-bone formation. The lower abscess was quickly opened, and, after taking some of the contained brown pus for laboratory examination, was carefully cleared out with its walls.

With the wound well covered, an X-ray picture was now taken. The film showed that the lower abscess had been cleared but the second and upper one was still intact. On returning to the wound the mass of new bone was followed up where it turned on to the palmar surface. Excavation was carried out from below so that the bone close to the capsule of the joint was left intact. The radiograph showed how close the second abscess was to the joint, infection of which from careless opening of the capsule would result in a stiff index finger. A second radiograph now showed that the upper bone cavity had been widely opened and cleared, leaving the joint intact (*Fig.* 560). The bone edges were trimmed and the periosteal flap with the muscle replaced over the bone. The skin was loosely sutured, the glove cut away, and a dressing applied. A posterior plaster cast was put on to hold the index in flexion at the metacarpophalangeal joint.

A temperature of 99° F., with a pulse of 80, was recorded during the first two post-operative days, but settled on the third day and did not return.

The skin sutures were removed on Feb. 6, the wound having healed *per primam*. The laboratory reported that a hæmolytic staphylococcus and a large, Gram-positive, fusiform bacillus had been isolated from the pus removed from the bone abscesses. Finger exercises at the interphalangeal joints were commenced on the second post-operative day. By March 17 finger movements were full, powerful, and equal to those of the left hand (*Fig.* 561). He reported himself well and had been on full duty for a month by April 20.

I have seen this patient since on several occasions. He has been through severe fighting in Burma and has had no trouble with this hand.

DISCUSSION

The story of this superficial abscess with pus containing the same organisms as the bone abscesses is interesting, raising the point of whether the original bite affected the bone or merely the superficial tissue above it. In the latter case the path of infection would appear to have been local spread to injured periosteum before an outlet through the palmar fascia was obtained and the abscess of September, 1943, appeared. The sequence in the history suggests a deep lesion involving periosteum and bone by the bite, and local abscess formation with partial evacuation through the fascia and skin in September. Meantime, local spread under the periosteum to the bone by the unevacuated part of this abscess took place to culminate in its being shut off under the new bone formed, with consequent appearance of clinical signs in November, 1943. The fact that the original bite healed so easily is of interest in view of the after-history and type of infection found to be present.

The approach to the bone used here is a good one, making use of a natural route offered by the local anatomy. I have used this route many times in other lesions of the 2nd metacarpal and especially for bone-grafting in fractures. It gives good access, does not disturb the blood- or nerve-supply of the parts, and preserves the 1st interosseus muscle and the fascial space around the extensor tendons. In the powerful hands of manual workers and soldiers the superficial fascia is often found to consist of two layers—a superficial fatty layer directly under the skin and a deeper fibrous layer. This arrangement caused me much difficulty on earlier occasions, for the well-developed layer of the superficial fascia gave the illusion of having reached the true deep fascia. Confusion thus arose and much stripping up of the wrong fascial layer led to unnecessary destruction of the fascial space around the extensor tendons, and of the blood-vessels and nerves which are exposed by this mistake. Knowledge of the disposal of fascial layers and the use of the technique described will keep the surgeon from such confusion.

The point in technique of arranging for a casette to be passed easily under the hand is an invaluable aid to operations upon these small long bones, especially where, as in this case, damage to the metacarpophalangeal joint has to be avoided at all costs. It is an arrangement well worth while in bone-grafting on these small bones, in open operations on the forearm bones, and in dealing with complex injuries involving the head of the radius, etc.

Management of a hand operation is always difficult, and many are the aseptic plans which go amiss through lack of forethought and attention to detail. The use of a wooden sphere as described gives the operator a hand to work on which is steady and easily controlled.

Use of a cotton glove with mastisol facilitates the application of towels and wound towels, again releasing the surgeon from another irritating feature of hand surgery upon which asepsis is frequently wrecked.

Care to avoid soiling the wound appears to have been responsible for primary healing here, and is well worth the trouble and more delicate manipulation required. No penicillin or sulphonamide was used. A set of Halsted mosquito forceps, fine-toothed and plain dissecting forceps, small retractors, small periosteal elevators, small mastoid chisels and gouge, and fine drills are an essential armamentarium for good hand surgery.

The value of carefully directed rehabilitation in the after-treatment of hands the subject of trauma, infection, or operation cannot be over emphasized. It is fortunately coming to be more and more realized that future function depends upon nothing so much as upon the correct use of this after-therapy.

SUMMARY

1. A case of human bite which healed easily followed by a superficial abscess and later still by a bone abscess is reported.

2. Both abscesses were infected by hæmolytic staphylococcocci and fusiform bacilli.

3. Surgical approach to the 2nd metacarpal shaft from the dorsum through the space between the 1st interosseous and the tendon fascial compartment is described.

4. The differentiation of a deep layer to the superficial fascia is described and the confusion it may cause with the true deep fascia is noted.

5. The usefulness of an arrangement for taking radiographs during operation is noted and an easy method described.

6. The use of a shaped wooden block for steadying the hand is described.

7. Emphasis is laid upon rehabilitation after hand infections and injuries.

LIGATURE OF AORTIC ARCH IN THE NECK

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TWELVE cases of ligation of the aortic arch have been reported, all of which died. This would seem obvious, and therefore it is important to give the reasons for tying this vessel. The present report describes another of these accidents with the reasoning that led up to the operation. The other point of note is the presence of the aortic arch in the neck,

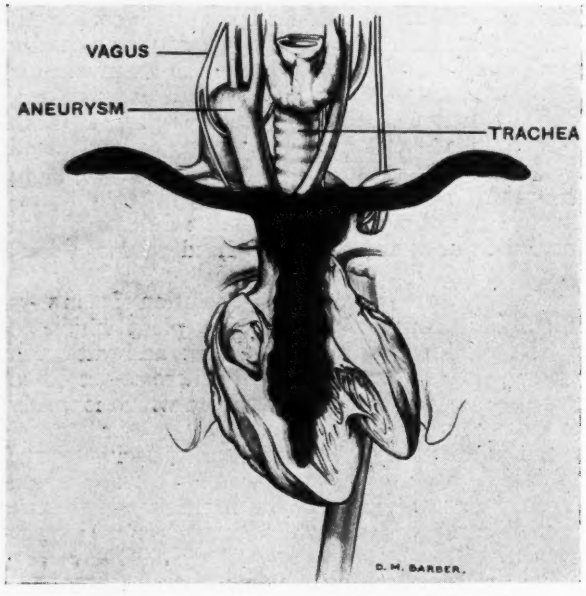

FIG. 562.—Sternum and clavicles superimposed on specimen.

ascending to the cricoid cartilage, appearing clinically as an aneurysm. This is the first case of the kind reported and is of interest both clinically and embryologically.

CASE REPORT

In March, 1943, we saw a girl of 9 with a pulsating swelling of the neck. Clinically it was an aneurysm of the right common carotid, producing a loud murmur and a thrill not transmitted upwards into its branches. On compression below, the aneurysm collapsed, the pulse slowed, and the face flushed. It could be compressed for four minutes without producing unconsciousness or other signs of cerebral ischæmia. It had been noticed for several years, but had become more prominent recently.

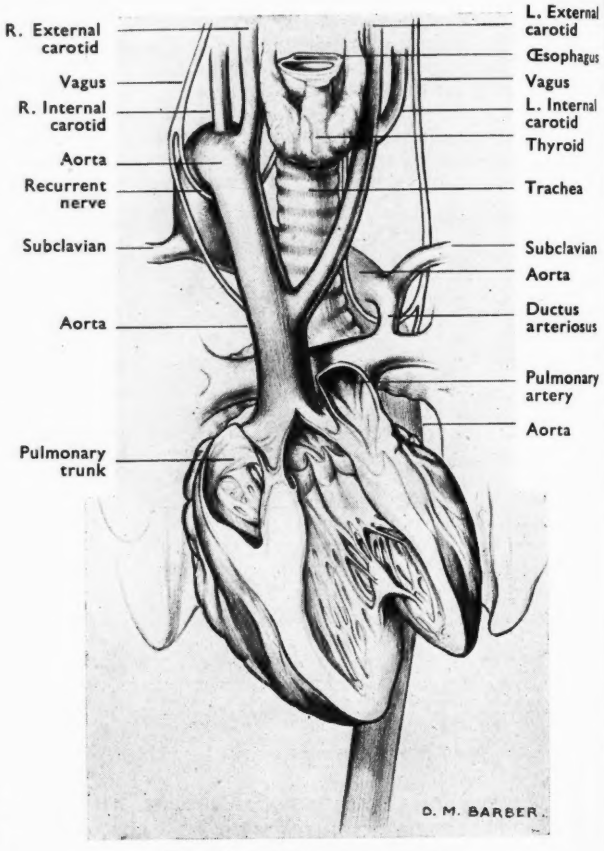

FIG. 563.—Post-mortem specimen.

Mantoux and Wasserman reactions were negative. A radiograph of the chest and neck showed no abnormality, except for the aortic knuckle, which might have been labelled ' small '. No cause for the aneurysm was found.

Nine months later the aneurysm was larger, about the size of a pigeon's egg, immediately above the right sternoclavicular joint, with a peculiarly sinuous expansile

pulsation and a strong thrill not transmitted upwards into the external carotid. The trachea was pushed to the left, there was shortness of breath on exertion, and, particularly to be noted, slight dysphagia on extending the neck. The swelling became much more prominent on raising the chin; it could not now be compressed owing to the very strong pulse pressure. Something recurrent laryngeal nerve curving around the dilated vessel. A rapid mental review of a very scanty repertoire of congenital anomalies was made, and it was decided that the aneurysm was one of the innominate arteries which had bulged upwards outside the thorax. There were no adhesions to surrounding structures, and the vessel was dissected out and tied as low as possible

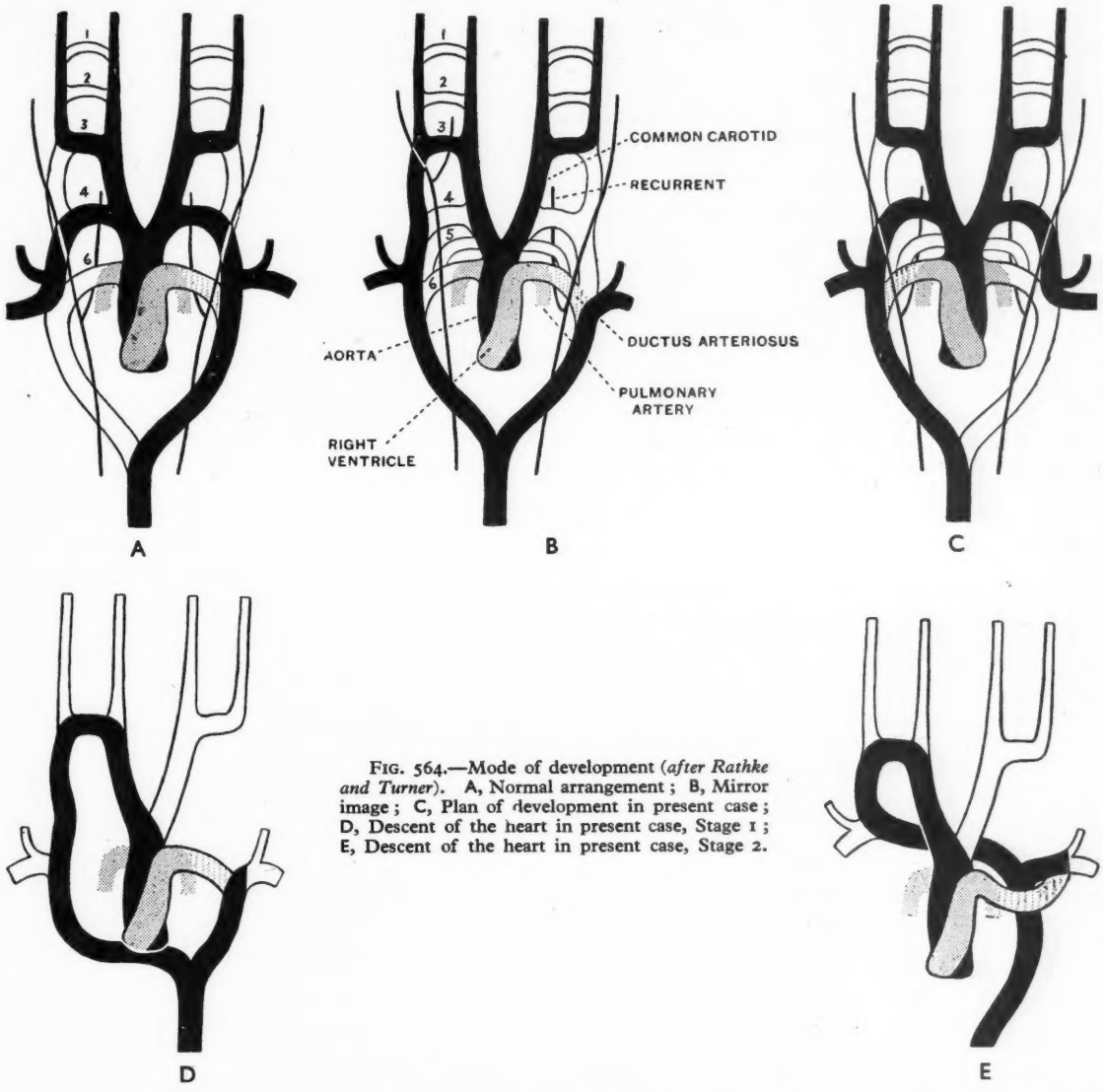

FIG. 564.—Mode of development (*after Rathke and Turner*). A, Normal arrangement; B, Mirror image; C, Plan of development in present case; D, Descent of the heart in present case, Stage 1; E, Descent of the heart in present case, Stage 2.

had to be done, as the symptoms were increasing, though not as yet urgent. Again a diagnosis of common carotid aneurysm was made (*Fig.* 562).

The literature on aneurysm in children showed that a number were due to endocarditis and rheumatism; others to acute infectious diseases, syphilis, caseous glands, and trauma; in a surprisingly high number of cases no cause could be found (Bronson and Sutherland, 1918; Pilcher, 1937). Recently Tanner (1945) has described one of the right common iliac arteries which showed no evidence of cause. Aneurysms of the ascending aorta were sometimes due to coarctation beyond it; most of these aneurysms had ruptured.

OPERATION.—In November, 1943, the neck was explored under general anæsthesia, through an oblique incision along the interior border of the right sternomastoid. The swelling bulged out as soon as the deep fascia was incised, and rather surprisingly showed the with a slip-knot, tightening the tape gradually. The aneurysm became much smaller, the right radial and carotid pulses stopped as expected, but no other untoward signs were noted, although the pulse-rate fell slightly. The left carotid was beating normally; five minutes later the ligature was released, and again tied with tape in two places. It was difficult to define the upper limit of the aneurysm, and reference to *Fig.* 563 explains why this was so. No further dissection was therefore done, but the wound was closed and the child put on the ward trolley; suddenly, about fifteen minutes after applying the ligature, she started to bring up large quantities of frothy sputum, and percussion of the chest showed that the heart was enormously dilated to the left, extending into the axilla. Within a few seconds the child was dead of acute left-sided heart failure.

AT AUTOPSY.—*Fig.* 563 demonstrates the post-mortem findings. It shows that the aorta passes upwards and

to the right, into the neck up to the level of the thyroid, then backwards and downwards and to the left behind the œsophagus. It reaches a position corresponding to the normal beginning of the descending portion of the aorta, and on a postero-anterior radiograph reproduces the appearance of an aortic knuckle. From here on it follows the course of the normal descending aorta. The subclavian arteries take origin on each side from the downward-coursing portion of the arch; on the left side the subclavian is joined by a ductus arteriosus that is only just patent. There were two grooves on the ascending part of the arch, where the ligatures were placed. The heart was normal and not inverted.

DISCUSSION

In most of its details the specimen corresponds to a right-sided aortic arch with persistent left root, of the type described by Arkin (1936). A very full description of this form of abnormality has been given by James W. Brown in his book, *Congenital Heart Disease* (1939). The one important detail that is new and not explained is the high position of the aortic arch.

An attempt is made to describe the anomalies by diagrams (*Fig.* 564). Diagram A shows the normal arrangement, with the branchial arches outlined; the normal aorta derives from the persistent left fourth arch, the normal innominate from the persistent right fourth arch, and the subclavian arteries are almost entirely segmental.

Diagram B shows a mirror image of the first picture in complete *situs inversus*. A similar inversion of the great vessels may occur without inversion of the heart. In reptiles both dorsal aortæ persist.

Diagram C, when compared with the previous diagram B, shows three deviations: first, the disappearance of the right and left embryonic aortic arches; secondly, the persistence of the thoracic aorta on both sides instead of only on the right; and thirdly, the abnormally high position of the right functional aortic arch.

For the discovery of why the aortic arch is in the neck, I am indebted to Professor O'Donoghue, Professor of Zoology at Reading University. A study of the specimen showed that the two right carotid vessels arose independently from the aorta. This led to another reference to the diagram and a sudden realization that in this case the gill slit responsible for the arch is not the fourth but the third. Hence, there is no innominate artery; the recurrent laryngeal nerve takes its place under the persistent branchial vessel—namely, the third instead of the fourth.

Anomalies of these arteries due to variations of the third and fourth branchial vessels are infrequent, but have been described by various authors including Morgagni, Malacarne in 1784, and J. D. Boyd (1934). Among these are found the absence of the common carotid artery, the internal and external carotids taking origin directly from the arch of the aorta on one or both sides; embryologically such an anomaly would arise from the disappearance of the third branchial artery and the persistence of a short portion of the dorsal aorta (ductus caroticus) which forms the beginning of the internal carotid.

The last two diagrams (D and E) explain how a relative slowing of growth of the left root (dorsal aorta) combined with the descent of the heart pulls the right descending aorta to the left, producing a vascular collar around the trachea and œsophagus, as in the present case. It is probable that it is the ductus arteriosus in fœtal life, with its preponderating importance, that has something to do with this pull on the dorsal aorta. As a result of this shortening, the origin of the left subclavian is, in fact, the persistent remnant of the embryonic left thoracic aorta.

A few words as to the diagnosis on a future occasion: The slight dysphagia, noticeable only when drinking a glass to the bottom, should have lead to a barium swallow, viewed laterally. A very characteristic notch is visible in cases of right-sided aorta with persistent left root, and presumably would have been seen in this case too (Rohan Williams, 1940). An œsophagoscopy would reveal the pulsating vessel, but the operation may be dangerous. Both before and during the operation it would have been found that compression of the cervical artery caused disappearance of the femoral pulses, but not of the left carotid. Later, if arteriography becomes easier and more practical, it may be possible to visualize such vessels by X rays; a similar anomaly on the left side has not been described, but is theoretically quite possible.

As to the correct treatment, our suggestion is that, as the upper outlet of the thorax becomes increasingly inadequate for both the ascending and descending aortæ, the first rib be removed on the side affected so as to give more space.

SUMMARY

A case is described of an aortic arch ascending into the neck up to the level of the cricoid on the right side. An embryological explanation is given to account for this anomaly, and a description of the clinical signs and possible treatment is given.

I wish to thank Professor C. O'Donoghue for his brilliant inspiration in explaining the embryology.

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GRANULOMA OF THE FALLOPIAN TUBE DUE TO SURGICAL GLOVE TALC

SILICIOUS GRANULOMA

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SINCE Shattock first showed that silica in the subcutaneous tissues could elicit the slow formation of a granulomatous mass, it has come to be realized that the silicious talc used as a dusting powder could similarly lead to granulomatous lesions in the peritoneum. The danger of this substance, and also of lycopodium powder, is not yet widely enough appreciated, doubtless because of the frequently long interval between deposition and the obtrusion of the resultant granuloma into clinical notice. For the same reason it is probable that granulomatous lesions found in the Fallopian tube, described in the past as tuberculous, have similarly not been appreciated, in fact, as cases of foreign-body granulomata. The present study of granuloma due to the presence of talc contains 5 cases with lesions of the Fallopian tube.

HISTORICAL REVIEW

Shattock (1916) gave the first example of a foreign-body granuloma due to silicious particles and called the lesion pseudo-silicoticum. He had previously urged the retention of the term pseudotuberculosis to indicate a non-infective granulomatous lesion characterized by a nodular appearance similar to tuberculosis with histologically a follicular arrangement of giant cells. A man developed a small tumour at the site of an injury to his lip 11 years previously. Histologically the lesion was characterized by a follicular arrangement of giant cells closely simulating tuberculosis, but examination by appropriate methods showed that the follicular arrangement was in relation to small refractile bodies believed to be silica.

Faulds (1935) described two further cases of pseudo-tuberculoma silicoticum, the lesions being removed 10 and 23 years after injury. The histological features of these cases were practically identical with that originally described by Shattock. Faulds achieved the absolute geological proof of the silicious nature of the foreign bodies present and, in addition, was able to demonstrate that they were identical with slate present on the ground where the original accident had occurred. A similar traumatic case was reported by Eden and Herbert-Burns (1936).

Antopol (1933) described 6 cases of foreign-body granulomata at various sites following operation and he identified in the lesions spores of lycopodium which he considered to be the causal irritant. In one instance (Case 4) following cholecystectomy he found small granulomata scattered over the whole peritoneal surface, but no mention is made of the state of the Fallopian tubes. He also reported a further case (Case 7) of a man who had undergone two previous abdominal operations. Subsequently the appendix was removed and Antopol found granulomata in the subserosa, which contained small refractile bodies "morphologically identical with talc". He did not, however, note the similarity of the lesions to the pseudotuberculoma silicoticum of Shattock.

Erb (1935) described a further 6 cases of granulomata in various sites subsequent to operation. He also demonstrated spores of lycopodium in the lesion and considered this the causal irritant. He was, however, aware that the dusting powder used at the original operation was a mixture of lycopodium spores and talcum powder, but does not appear to have appreciated the irritant qualities of talc and made no search for it in the granulomata.

Feinberg (1937) and Gardner (1937) described cases of foreign-body granuloma due to talc in the scars of previous operation. Gardner emphasized the similarity to tuberculosis and German (1940) reported a further case as a lupoid sarcoid reaction due to talc.

McCormick and Ramsey (1941) recorded widespread intraperitoneal formation of talc granulomata following a number of diverse abdominal operations. Ramsey (1942) described a number of further examples in which lesions were found in the pelvis, but he noted no abnormality in the Fallopian tubes although two of his cases underwent bilateral salpingectomy.

German (1943) reviewed 50 cases of talc granuloma following laparotomy. The majority of the lesions he described were in the omentum and peritoneum, but he also found granulomata in the ovaries. He makes no mention of involvement of Fallopian tubes. In endeavouring to establish the relationship between the deposition of talc in the peritoneal cavity and the formation of granuloma, he showed experimentally that in the absence of trauma the talc particles migrated widely before lodging and setting up a reaction. He did not notice any preponderance of the lesion in the pelvis.

A number of investigators—Jones and Rouse (1914), Cappell (1930), and Thomas (1936)—have studied the disposal of various foreign bodies introduced experimentally into the peritoneal cavity, but have not noted any lodgement in the Fallopian tubes in the animals with which they were working.

Seelig (1943) and his co-workers carried out an experimental investigation of the role of talc, stressing the importance of talc introduced at operation as a cause of granuloma and peritoneal adhesions. They also sought a substance suitable as a dusting powder without the irritant effects of lycopodium or talc and which could be used as a dusting powder for rubber gloves. They decided that potassium bitartarate was the most suitable substitute for talc, since it was soluble and was absorbed without eliciting any reaction.

The only site other than the subcutaneous tissue, operation wounds, and the peritoneum, in which the relationship of silica and granulomatous formation has been reported, is the submucosa of the stomach; this was found by Cohn et al. (1941) in a patient who had been taking aluminium silicate (kaolin) for years as an antacid.

'Pseudo-tuberculoma silicoticum', suggested by Shattock, has the merit of indicating both the causal irritant, silica, and the morphology, which till then was, and even yet is, confused with that of tuberculosis. More recently the term 'talc granuloma' has come into use in America. In the present series it is presumed that the aetiological silicious matter is in fact talc, but it is proposed to use the term 'silicious granuloma'.

CASE REPORTS

The 7 cases in this series of granuloma due to talc as foreign body all had a previous operation during which one must presume the irritant material was introduced. In 2 cases the resultant lesion occurred in the scar in the abdominal wall; in the other 5 granuloma developed in the Fallopian tubes.

In all cases in this series a thorough search was made for acid-fast bacilli in sections stained by the Ziehl-Neelsen method and none was found.

GRANULOMATA IN OPERATION WOUNDS

Case 1.—C. S., 1213/42, aged 30. Housewife. Admitted Nov. 19, 1942.

HISTORY.—

General: Swelling of appendicectomy scar and some pain on exertion appeared 12 years after a successful appendicectomy.

Obstetric: Married 8 years, nulliparous.

EXAMINATION showed a large nodular mass in the scar, but otherwise no abnormality was noted.

Nov. 23: Scar excised.

PATHOLOGY.—A large irregular mass of tissue measuring 3 × 3 × 7 cm. is seen running the whole length of the scar. The gross features of the specimen are similar in many respects to a keloid; on section it presents a distinctly nodular appearance. Histological examination shows the mass to be composed of multiple follicles containing giant and endothelioid cells (*Fig.* 565). Examination with the polarizing microscope reveals numerous small anistropic particles intimately related to the giant cells which in the main are grouped around them. The majority of the particles are small and spicular (*Fig.* 566), but there is considerable variation in size and shape.

Case 2.—488/43, male, aged 34. Admitted April 30, 1943.

HISTORY.—Swelling of appendicectomy scar and some pain on exertion appeared 11 years after a successful appendicectomy.

EXAMINATION revealed a large irregular mass measuring 2 × 3 × 8 cm. distending the scar.

April 30: Excision of scar.

PATHOLOGY.—Both the macroscopical and histological features of the mass are virtually identical with those described in *Case* 1.

SUMMARY.—The histological picture of both these cases is identical with the subcutaneous traumatic form of pseudo-tuberculoma silicoticum described by Shattock and Faulds; in both it seems highly probable that the silicious matter is talc and that it was introduced at the original operation.

GRANULOMATA IN FALLOPIAN TUBES

Case 3.—B. McG., 656/41, aged 28. Laundry worker.

Admitted Aug. 19, 1941, complaining of pain in the left iliac fossa of several weeks' duration.

HISTORY.—

General: The patient had an appendicectomy two years previously, but otherwise health had been good. Recently she has been suffering from pain in the left iliac fossa.

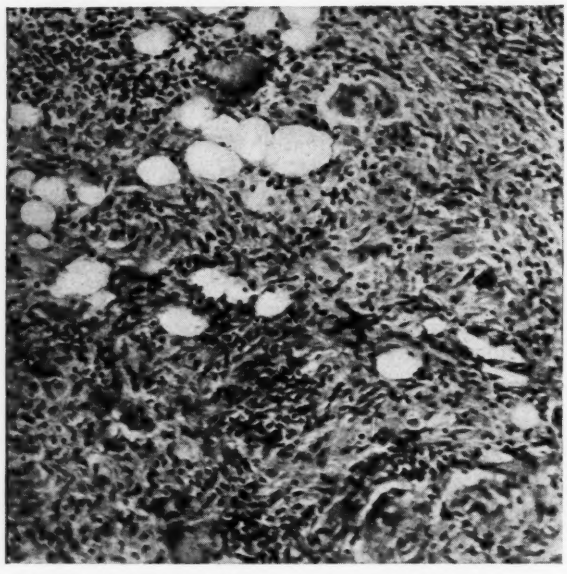

FIG. 565.—*Case* 1. Nodule from surgical abdominal scar eleven years after appendicectomy. This somewhat follicular granuloma shows the characteristic giant-cell tissue and fibrous reaction. (H. and E.) (× 150.)

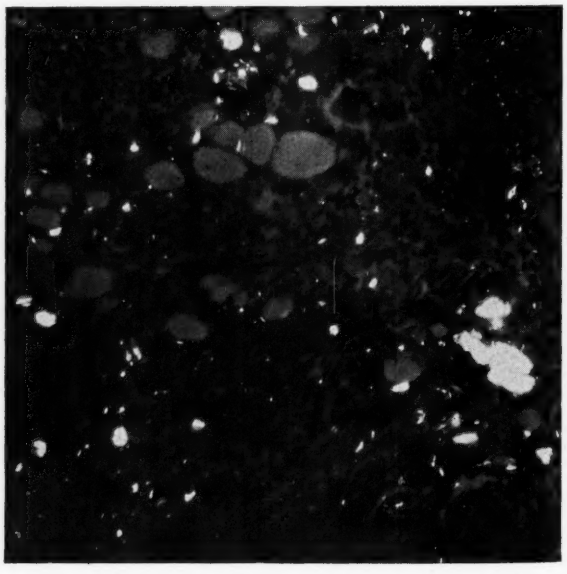

FIG. 566.—*Case* 1. The same field as in *Fig.* 565 taken through polaroid screens. This shows numerous anisotropic foreign bodies closely related to the giant cells. Some of the particles are definitely spicular (*see Fig.* 572). (H. and E.) (× 150.)

Obstetric: Para 1, 6 years ago. N.F.T. Normal puerperium. No further pregnancies.

Menstrual: F.M.P. 16 years; L.M.P. Jan. 24, 1941. Cycle 7–10/28, regular.

ON EXAMINATION.—

General: Slight tenderness in left iliac fossa.

Vaginal: Marked pain and tenderness in both left and right fornices.

Aug. 28: Bilateral salpingectomy performed. Convalescence uneventful.

PATHOLOGY.—Both Fallopian tubes are considerably thickened but otherwise no features of note are seen on naked-eye examination. Histological examination shows gross abnormality of the mucosal villi which are thickened and in many places fused together, thus considerably reducing the lumen of the tubes (*Figs.* 567, 568).

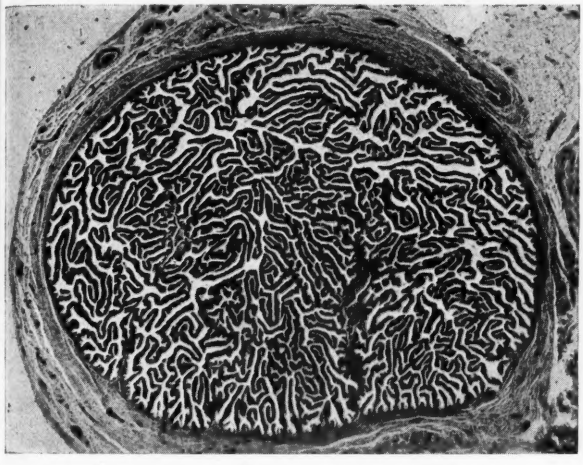

FIG. 567.—Normal Fallopian tube, ampullary portion. The characteristically delicate villous structure is clearly seen. (H. and E.) (× 12.)

Numerous follicles containing large Langhans-type giant cells are present throughout the swollen villi. These occur mainly in follicles centred around small crystalline particles. A few endothelioid cells are also present, but in the main these are scanty. A dense infiltration with lymphocytes is present around the follicles. Examination with the polarizing microscope reveals numerous small anisotropic particles intimately related to the giant cells and in many cases contained within them.

While the failure to find tubercle bacilli does not exclude tuberculosis, the combination of the histological finding of doubly-refractile particles and giant cells in follicular systems, and the fact of a previous laparotomy, suggests that this is probably a foreign-body granuloma.

Case 4.—E. T., 1256/45, aged 32. Housewife. Admitted Oct. 17, 1945, complaining of sterility.

HISTORY.—

General: The patient had rheumatic fever in 1926 and acute appendicitis in 1928. Recovery from appendicectomy was rapid and since then she has been in good health. An enlarged gland, stated to have been tuberculous, was removed from her neck in 1943.

Menstrual: F.M.P. 14 years; L.M.P. Oct. 13, 1945 (4 days before admission). Cycle 5/28, regular. No discharge or dysmenorrhœa.

Obstetric: Married 9 years. Nulliparous.

ON EXAMINATION.—

General: Reveals nothing of note.

Vaginal: Vulva and cervix normal. Slight tenderness in left lateral fornix with enlarged and thickened Fallopian tube.

OPERATION (Oct. 20).—Bilateral salpingectomy.

PATHOLOGY.—Both Fallopian tubes are considerably thickened but otherwise show no gross abnormality. Histological examination shows great thickening of the mucosa and matting of the villi. Multiple follicles containing giant cells and anisotropic foreign bodies are present throughout. The histological features are closely similar to those in the previous case.

Case 5.—J. M. P., 371/46, aged 35. Housewife. Admitted March 15, 1946, complaining of a feeling of weight in the lower abdomen.

HISTORY.—

General: The patient had an appendicectomy about 10 years ago and has been in excellent health till 6 months ago when she began to experience slight lower abdominal discomfort with some pain and a feeling of heaviness coming on at any time and unrelated to menstruation.

Menstrual: F.M.P. 14 years; L.M.P., Feb. 24, 1946. Cycle irregular, 5–6/19–23.

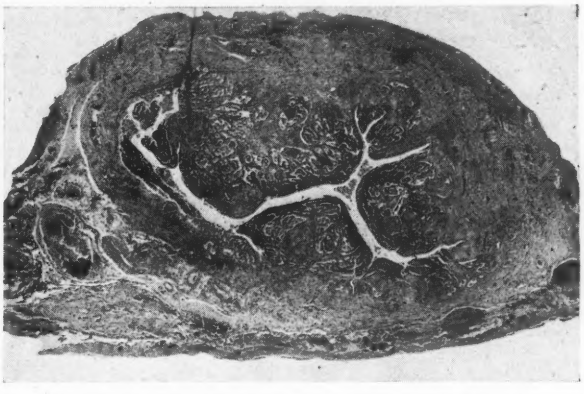

FIG. 568.—*Case* 5. Fallopian tube. The normal structure of the mucosa is destroyed. The villi are submerged in the granulomatous masses. (H. and E.) (× 9.)

Obstetric: Married 9 years. Nulliparous.

ON EXAMINATION.—

General: Reveals no abnormality.

Vaginal: There is a large firm mass attached to the uterus, considered to be a subserous fibroid.

AT OPERATION (March 10).—Myomectomy and left salpingo-oöphorectomy. (There is, unfortunately, no note of the appearance of the right Fallopian tube as seen at operation.)

Convalescence was uneventful.

PATHOLOGY.—The Fallopian tube shows a moderate degree of thickening, being about 1·5 cm. in diameter. The fimbriated end of the tube is adherent to an apparently normal ovary. The serous coat covering the tube seems thickened, but there is no suggestion of subperitoneal tuberculous nodules.

The histological features are similar to those seen in the two previous cases. The mucosa is thickened and the papillary processes are grossly distorted and destroyed (*Fig.* 568); in them are numerous giant-cell follicles containing doubly refracting particles. At two points lymphatics in the muscular coat of the tube are seen to contain a cellular mass consisting mainly of lymphocytes; these masses show central necrosis, but there is little evidence of cellular reaction around the lymphatics and no giant cells are present in this region. Histological examination for foreign bodies and for tubercle bacilli in this area have both proved unsuccessful. Since there is a large amount of silica present elsewhere in the section, it may be suggested that the necrosis of the cellular exudate in the lymphatics is due to the action of soluble or gel-form silica.

The ovary presents no abnormality, showing normal maturation of Graafian follicles, and a large well-formed corpus luteum, evidence of recent ovulation.

Case 6.—M. Y., 58/46, aged 26. Housewife. Admitted Jan. 3, 1946, complaining of post-menstrual pain during the last four months.

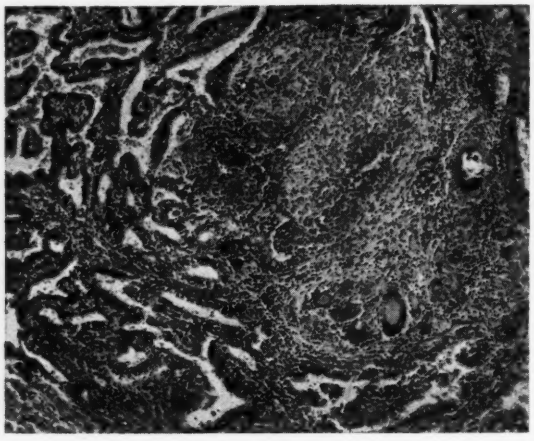

FIG. 569.—*Case* 6. Fallopian tube. This shows to the right the granuloma with its giant cells and somewhat follicular arrangement; to the left the villous structure is still obvious. (H. and E.) (× 36.)

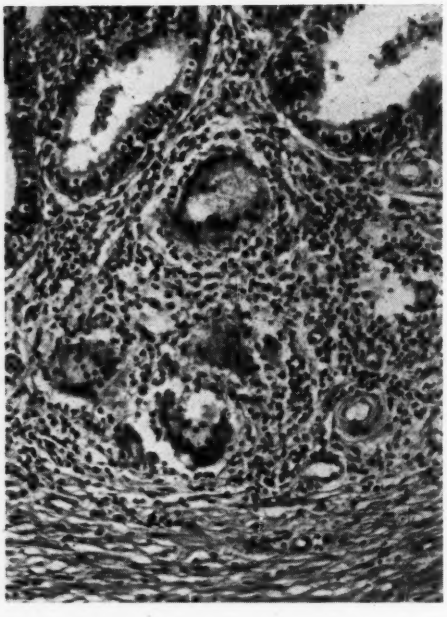

FIG. 570.—*Case* 6. Fallopian tube. This zone contains several giant cells with surrounding lymphocytes. The wall of the tube is seen below. (H. and E.) (× 150.)

HISTORY.—

General: The patient had an appendicectomy 8 years ago. The abdominal wound discharged for some time and healing was slow, but otherwise convalescence was normal.

During the past 4 months the patient experienced fairly severe pain following menstruation. On each occasion this lasted about one week.

Menstrual: F.M.P. 13 years; L.M.P. Dec. 6, 1945. Cycle 5/28, regular. No discharge or dysmenorrhœa.

Obstetric: Married 6 years. Nulliparous.

ON EXAMINATION.—

General: The patient is a well-nourished young woman and no gross abnormality is noted.

Vaginal: Thickened masses felt in both right and left fornices are considered to be tubo-ovarian in origin.

OPERATION (Jan. 6, 1946).—Bilateral salpingo-oöphorectomy.

PATHOLOGY.—On each side the Fallopian tube is firmly adherent to the ovary by a thick layer of fibrous tissue, the whole forming an oval mass approximately 7 × 4 × 3 cm. In neither of these swellings could the normal anatomical features be made out.

Histological examination shows no very gross abnormality in the ovary underneath the encasing sheet of fibrous tissue. There is evidence of ovulation and maturation of the Graafian follicles. The Fallopian tubes and all the structures of the parovarium are closely bound to the ovaries by very dense fibrous tissue. The tubes show gross alteration of their architecture; the villi are considerably thickened and show dense infiltration with chronic inflammatory cells, mainly lymphocytes. In addition, there are numerous follicles, with large giant cells (*Fig.* 569), situated mainly in the deeper layers of the mucosa adjacent to the muscular coat. Closely related to, and in many instances actually contained within the giant cells, are irregular particles mostly of a yellowish-brown colour varying in size from 3 to 15μ in diameter. Examination with the polarizing microscope reveals that these particles are doubly refracting (*Figs.* 570, 571). This case differs from the previous three, not only in the presence of bilateral tubo-ovarian fibrous adhesions, but also in having had a post-operative infection after her appendicectomy and it seems not unreasonable to relate these; certainly the silicotic granulomatous reaction is confined to the tube and absent from the ovarian region. One has to presume that the ostium stayed patent enough to allow the entrance of the silica!

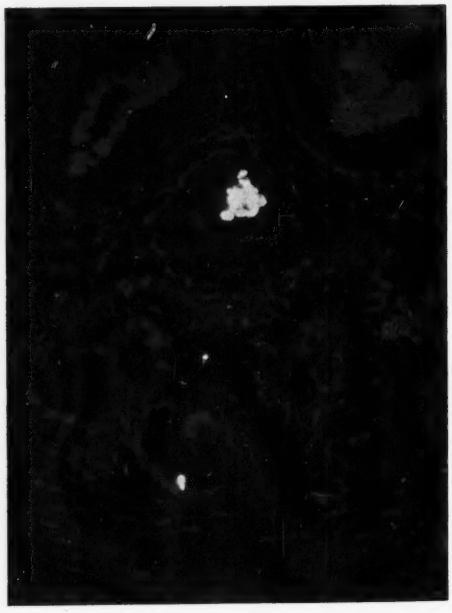

FIG. 571.—*Case* 6. Fallopian tube. This shows the same field as the previous section through polaroid screens. The foreign body recognizable in the previous section is seen to be doubly refractive. The smaller anisotropic articles are of the type that in practice one finds by polarized light and confirms by ordinary light as being intracellular. (H. and E.) (× 150.)

Case 7.—N. M., 344/46, aged 30 years. Housewife. The patient was admitted on March 5, 1946, complaining of lower right abdominal pain of three weeks' duration.

HISTORY.—

General: Eleven years ago the patient had an appendicectomy for acute appendicitis. There was no evidence of peritonitis at the operation and the wound was closed without drainage. Convalescence was uneventful. The patient was well till 3 weeks before admission, when she had a sudden attack of right-sided lower abdominal pain. This was acute and stabbing in character and persisted for a week before subsiding, but it returned again after an interval of a few days. The pain travelled round into her back. During this time she had considerable frequency of micturition, rising 3–4 times at night.

Menstrual: F.M.P. 14 years; L.M.P. Feb. 17, 1946. Cycle 7/21, regular. No premenstrual or menstrual pain.

Obstetric: The patient had a five-months' abortion 10 years ago. There was no evidence of sepsis and recovery was rapid. Since then she had had no further pregnancy.

EXAMINATION.—

General: Revealed nothing of note.

Vaginal: Extreme tenderness in right lateral fornix with palpable mass. Uterus appears normal.

OPERATION (March 11, 1946).—Right salpingo-oöphorectomy.

PATHOLOGY.—The Fallopian tube is grossly swollen and the fimbriæ have disappeared, the distal end of the tube being somewhat bulbous. The tube is closely adherent to the ovary, which otherwise appears normal.

Microscopical examination shows gross thickening of the lining with an almost obliterated lumen. The submucosa is replaced by a cellular granulation tissue, infiltrated with inflammatory cells, mainly lymphocytes, plasma cells, and eosinophils, with scanty neutrophils. Epithelial cells occurring in cords are seen in the thickness of this tissue and they are taken to mark the former division into villi; elsewhere they are largely gone. In the deepest portion of the submucosa numerous giant-cell systems are also present and anisotropic foreign bodies are found in relation to these.

The sections are interpreted as showing a combination of a long-standing low-grade pyogenic salpingitis probably to be related to the abortion 10 years before, and a granulomatous reaction to foreign bodies introduced during the appendicectomy the year before the abortion.

SUMMARY OF SIGNIFICANT CLINICAL FEATURES

1. Lesion occurring in Scar Wound.—Both cases are characterized by the development of a mass in the scar of a previous operation wound with moderate pain or discomfort at this site. The differential diagnosis clinically is from keloid, which, however, generally occurs within a year of operation.

2. Lesions in the Fallopian Tube..—All 5 cases had undergone a previous laparotomy for appendicectomy and apart from the abortion in *Case* 7 the patients were all subsequently sterile. The symptoms are suggestive of a low-grade pelvic inflammation and physical examination reveals thickened tender Fallopian tubes. In *Case* 5 the tubal lesion was found during operation for the removal of a large uterine fibroid (*see Table I*).

Only one patient (*Case* 4) gives a history of a possible tuberculous infection elsewhere, having had cervical adenitis two years previously. X-ray chest investigation was not undertaken, but no abnormal findings were noted on clinical examination. No history of gonococcal or syphilitic infection was obtained and the sera from all patients gave a negative Wassermann reaction.

Table I.—DETAILS OF CASES WITH LESIONS IN FALLOPIAN

CASE NO.	AGE, YEARS	YEARS SINCE APPENDICECTOMY	MARRIED YEARS	PARITY SINCE APPENDICECTOMY	COMPLAINT	CLINICAL FINDINGS
3	28	2	7	—	Pain in left iliac fossa	Tenderness in fornices
4	32	17	9	—	Sterility	Thickened F.T.'s
5	33	10	9	—	Abdominal discomfort	Subserous fibroid
6	26	8	6	—	Post-menstrual pain	Tubo-ovarian masses
7	30	11	10	5/12 abortion	Lower abdominal pain	Tenderness and mass in right fornix

COMMENTARY

The scar lesion, not hitherto mentioned in the British literature, is of interest in that its close histological similarity to the commoner traumatic lesion and its obvious relationship to the introduction of foreign material at operation provide a linkage with the lesions in the Fallopian tubes. The possibility that a granuloma due to talc might occur in the latter site has apparently not been considered, but the finding of 5 cases of granulomatous salpingitis, in all of which doubly refractive material has been demonstrated, suggests that this is a not so rare late complication of laparotomy.

Differential Diagnosis.—The histological diagnosis of tuberculosis of the Fallopian tube is an easy matter in the typical case with gross caseation. In the diagnosis of the more proliferative form, the possibility of a silicious aetiology has now to be considered, but in this series the cases in which doubly refractive material has been definitely recognized have shown few, if any, cells that would properly be classified as endothelioid. The possibility that some, if not all, of the present cases have really been examples of silico-tuberculosis is difficult to exclude, since neither culture nor animal inoculation was undertaken in any and the failure to demonstrate tubercle bacilli in the sections cannot be taken as strong evidence, since it is well known how difficult such demonstration frequently is except in the florid type of tuberculosis.

It would seem reasonable in the microscopical examination of the pathological Fallopian tube to accept as primarily silicious a giant-cell granulomatous reaction, with scanty or absent endothelioid cells, absence of caseation, and the presence of doubly refractive material within or closely related to the giant cells. Since the spicules may be very scanty, extremely small, and difficult to see even with the polarizing apparatus, it is advisable in dealing with such a doubtful case to examine sections from several levels in the tube.

The Refractile Material.—The use of the polarizing microscope is of great value both in

detecting and in identifying foreign bodies present in tissue. Stewart (1920) found it of great assistance, particularly in detecting fragments of buried sutures, and investigated the other relatively few causes of double refraction, e.g., collagen fibres, red blood-cells, striated muscle, suture material, and extraneous debris. In the present series the only doubly refractive material accepted as diagnostically significant was that contained within or closely related to foreign-body giant cells.

Morphologically these foreign bodies are most commonly spicules of various lengths, although when within a giant cell they are frequently rounded (*Fig.* 571). This form is seen commonly in the lesions of the Fallopian tube, while spicules are the usual form in the lesions from the abdominal wall (*Fig.* 566). Not all the spicules visible with ordinary light proved to be anisotropic.

Talc, also known as French chalk, soapstone, or steatite, is a naturally occurring magnesium silicate of constitution 3 (MgO), 4 (SiO_2), H_2O, and belonging to crystal system number 4 (Kingzett). The

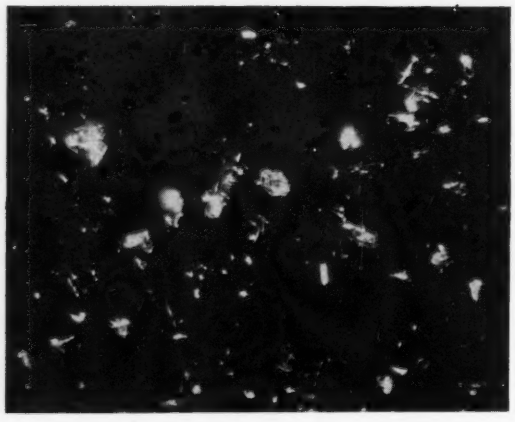

FIG. 572.—Preparation of surgical talc, magnesium silicate. Seen through polaroid screens. This should be compared with *Fig.* 566. (× 150.)

standard hospital talc, as used by surgeons for dusting gloves, shows under the microscope a marked similarity in shape and size to the particles present in the tissues. It is noteworthy that not all the particles present in preparations of ordinary surgical talc are doubly refracting (*Fig.* 572).

The more exact identification of the material in the histological sections is a matter of some difficulty. In the traumatic cases described by Faulds the particles were of sufficient size to permit accurate chemical investigation, but in the present cases the particles are very much smaller. However, by the method of Belt and Ferris (1942) the silicious nature of the spicules has been established. Sections from *Case* 3 were ashed in a micro-incinerator at 600° C. for one hour to remove all organic material, and then treated with concentrated hydrochloric acid to dissolve out the mineral salts; by this means every substance other than silica is removed from the section. The spicules previously seen were still present.

Thus, not only do the spicules have the size and shape of talc, but they are also proved to be silicious.

Genesis of the Lesion.—The formation of a silicious granuloma in a laparotomy scar seems to differ little from the more common traumatic silicious granuloma. There is the same long latent period and then the production of a characteristic tissue change. The question remains as to the mode of arrival of the silica in the subcutaneous tissues. It seems certain enough that in the post-operative type the silica comes on the surgeon's gloves as talc. Weed and Groves (1942) state that tear or puncture of surgical gloves occurs in about 75 per cent of all operations, and there is, of course, usually a quantity of talc lying in the nail fold; but perhaps even more significant is the statement of Seelig (1943) that talc can be removed from the outer surface of gloves only with the greatest difficulty. Once the talc is deposited in the tissues it appears to be dormant even for years.

This long latent period has also been emphasized by both Shattock and Faulds, dealing with the traumatic type, and indeed recently in this department a small subcutaneous silicious nodule was examined which had developed about 45 years after the original injury. One of the silicious granulomata arising in an appendicectomy scar (*Case* 1) apparently developed within two months, although the operation had occurred some 11 years before.

The development of the actual lesion in the Fallopian tube is presumably similar to that described in traumatic and post-operative silicious granuloma since it differs from them histologically in minor points only. There seems little doubt that the talc must have been deposited in the peritoneal cavity during operation and the particles may indeed be deposited directly in the pelvis since it is the practice of some surgeons to inspect and palpate routinely the tubes and ovaries.

The possibility is raised, however, by these cases that talc left in the peritoneal cavity at operation may become concentrated in the Fallopian tubes. Once there, the particles penetrate the epithelium and set up a foreign-body granulomatous lesion. The ultimate and important result of this lesion is the architectural disorganization of the delicate structure of the tube; this has been associated in all 5 cases with a serious effect on the fertility of the woman.

Relationship to Tuberculous Endometritis.—Within recent years a number of reports have described the finding of tuberculous infections in the endometrium of patients whose only complaint was sterility. Bacteriological investigation of such cases has been made by Sutherland (1943), who, with culture or guinea-pig inoculation, obtained 10 positives out of 16 cases examined. Rabau (1943) examined 4 cases and got 4 positives and Halbrecht (1946 a, b) obtained 7 positives out of 45 cases. There is, therefore, little doubt that a true infection of the endometrium by the tubercle bacillus does in fact occur. Novak (1941) states that in his experience a tuberculous lesion of the tubes is always present in cases showing tuberculosis of the endometrium, and considers that the endometrium becomes infected by material escaping from the Fallopian tubes, and it appeared possible that silicious material could similarly escape and set up a granulomatous reaction in the mucosa. The re-examination of some thirty specimens previously diagnosed as tuberculous

endometritis was undertaken and in none of them was silicious material detected.

Clinical Importance.—The danger of introducing talc into the tissues or body spaces is becoming recognized (*The Lancet*) and suggestions have been made to substitute as glove powder less irritant and less persistent substances (Seelig, 1943), but it is perhaps not yet adequately appreciated that talc in the tissues of the abdominal wall can not only give rise to a painful granuloma, but also, in probably a fairly large number of cases (German, 1944), can act as an irritant in the peritoneum and lead to the formation of adhesions.

To these has now been added the possibility that talc particles can settle in the Fallopian tubes and set up there a granulomatous reaction. The finding of 5 such cases within a year at the Western Infirmary, Glasgow, suggests that the lesion is by no means rare. This view is strengthened by the finding of 6 other cases in material filed in other departments as tuberculous salpingitis. It is consequently felt that this condition is of importance not only as a late complication of laparotomy that may demand further operative intervention for the relief of pelvic pain, but also as a cause of sterility.

Treatment of this condition must be prophylactic since surgical cure is unlikely to be possible. When once the silicious particles are deposited it is improbable that surgical treatment could prevent the ultimate occlusion, functional if not organic, of the Fallopian tubes. It is only by recognition of the dangerous potentialities possessed by talc and by a total avoidance of its use that these unfortunate sequelæ can be prevented.

SUMMARY

Seven cases of silicious granuloma are described, 2 occurring in appendicectomy scars and 5 in the Fallopian tubes.

All occurred in cases that had undergone a previous laparotomy, and microscopy revealed the presence in all the lesions of doubly refractive material; this is considered to be talc deposited at the earlier operation. Several of the tubal lesions had been previously diagnosed as tuberculous and the question is raised whether some cases diagnosed histologically as tuberculosis of the endometrium may not, in fact, be also silicious granuloma.

The presence of this type of lesion in the Fallopian tube can cause pelvic pain and apparently sterility.

I am glad to acknowledge my thanks to Dr. A. C. Lendrum for providing me with the material from *Cases* 1 and 2, and for his help in the preparation of this paper.

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AN OPERATION FOR NERVE PEDICLE GRAFTING

PRELIMINARY COMMUNICATION

By F. G. St. CLAIR STRANGE

ORTHOPÆDIC SURGEON, KENT AND CANTERBURY HOSPITAL AND RAMSGATE GENERAL HOSPITAL
LATE SENIOR SURGEON AND SURGEON-IN-CHARGE OF THE PERIPHERAL NERVE INJURY UNIT, MINISTRY OF PENSIONS' HOSPITAL, DUNSTON HILL

Many attempts have been made in the past to bridge wide gaps in peripheral nerves by nerve-grafts. Apart from thin grafts, such as cable grafts made from cutaneous nerves, facial nerve-grafts (Duel, 1934), and experimental grafts in rabbits (Young, Holmes, and Sanders, 1940), the usual results have been disappointing. In the light of recent work by Seddon and Holmes (1944) and Barnes, Bacsich, Wyburn, and Kerr (1946), homografts seem to hold no better prospects of success than heterografts.

In the case of full-thickness autografts, Sanders (1942) records that a frequent microscopical finding is central necrosis of nerve elements, and Sanders and Young (1942) quote many workers as obtaining similar results. Seddon, however, has had some remarkable results from full-thickness free autografts (1946). Fifteen of his 22 cases have been followed up for a sufficient period for results to be assessed, and in 9 of these recovery is as good as the best results from direct suture. At the same time, necrosis has been present in one of his failures.

From this evidence it seems probable that free grafts are capable of survival only if they are thin enough. It seems sensible to assume that there is

a critical thickness over which a free graft will be liable to central necrosis or collagenization and that, below this thickness, the graft survives by virtue of the accessibility to all its Schwann tubes of diffused oxygen, pending the establishment of adequate vascularization.

It therefore appears desirable to preserve the blood-supply of a full-thickness graft if possible. This has often been done before, but so far without adequate regard to the essential design of the graft itself. (Sanders' summary, 1942.)

This paper describes a rational operation for a nerve pedicle graft. The blood-supply is maintained during transfer by making use of the very efficient longitudinal vasa nervorum (Durward, 1944), and the principle is exactly comparable with the familiar full-thickness skin pedicle graft.

CASE REPORT

W. W. had sustained a severe shell wound of the right forearm on July 30, 1944, with compound fracture of both bones and residual stiffness of the elbow. Further, exploration had shown that there was complete destruction of both median and ulnar nerves over a distance of 12 cm., from a point 6 cm. below the elbow to one 6 cm. above the wrist (*Fig.* 573). A pedicle nerve-graft was therefore devised, using the ulnar to repair the gap in the median (*Fig.* 574).

Operative Technique.—

FIRST STAGE (June 28, 1946).—After adequate exposure, the neuromata of the median and ulnar nerves were resected and two proximal faces, containing good bundles, were found. The portion of the ulnar nerve to be used as the graft was then cleared and transected 13·5 cm. higher. This was done in such a way as to leave one large longitudinal vessel, visible in the epineurium, intact. In addition, two small lateral vessels near the upper end of the graft were also preserved. During suture of the two distal faces to each other, it was noticed with satisfaction that there was some oozing from that of the graft. The graft was left lying subcutaneously (*Fig.* 575) and the wound closed.

On examination seven weeks later a positive Tinel's sign could be obtained in the graft 5 cm. above the suture line.

SECOND STAGE (Aug. 9).—The ulnar graft and the suture line were exposed, the latter being left incompletely cleared to avoid damaging any new anastomoses

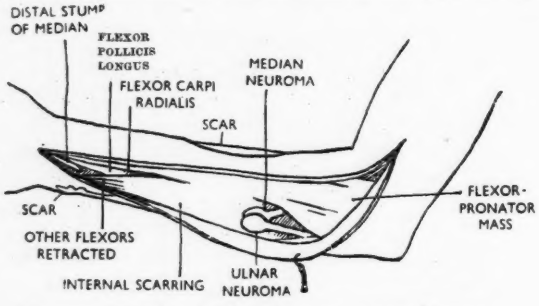

FIG. 573.—Drawing showing appearances at exploratory operation.

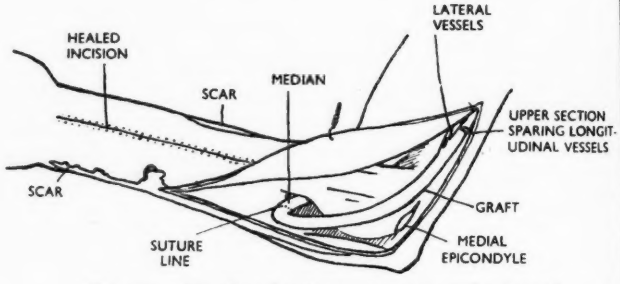

FIG. 575.—Drawing showing appearances at the close of the first stage of the pedicle graft.

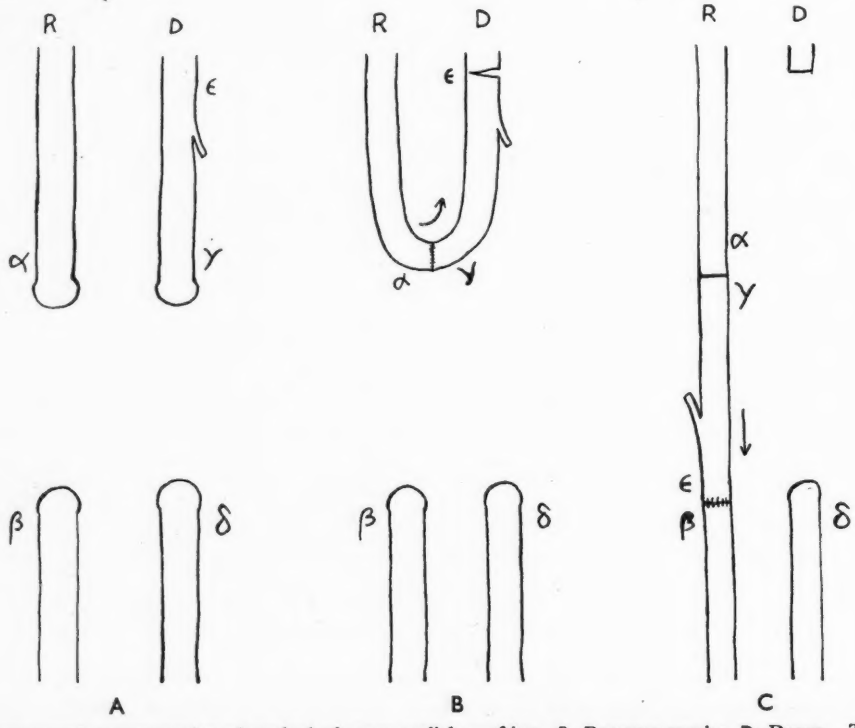

FIG. 574.—Diagrammatic representation of method of nerve pedicle grafting. R, Receptor trunk; D, Donor. The Greek letters are for identification. The arrows show the direction of regeneration. A, Type of lesion for which the operation is suitable; B, First stage—blood-supply to the graft at ε; C, Second stage—blood-supply to the graft at γ.

around it. The graft was more closely defined and appeared healthy; the distal (now physiologically proximal) end was of full thickness and normal consistency, but the end farthest from the suture line was small and felt 'empty'. This end was now divided and swung down through a subcutaneous tunnel and sutured to the distal end of the median after resection of the latter had revealed fair bundles (*Fig.* 576). There was brisk bleeding from the graft face at a time when its sole blood-supply was across the suture line, 12·5 cm. away.

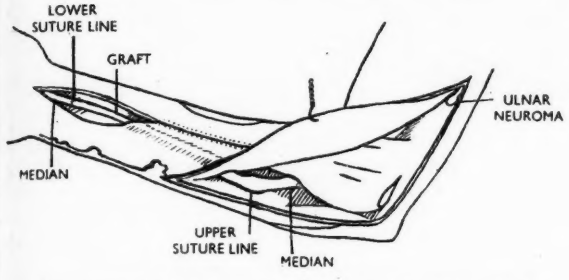

FIG. 576.—Drawing to give a general impression of the position of the graft at the completion of the second stage.

One or two points in the technique may be enlarged upon here. First, section at the higher level is necessary in order that the outgrowing axons of the receptor nerve may have suitable Schwann tubes to enter. Secondly, the distal end of the graft should be resected until good bundles are seen before dividing it at the higher level. In this way, undue dwindling of the graft from the necessity for unexpectedly wide resection need not be feared. Thirdly, the upper point of section of the donor nerve need not necessarily be at the place which will subsequently become its distal face. The higher above this level the better, so that, with the intervening trunk left unstripped, there will be the best available blood-supply for the graft during the first stage. Indeed, the graft itself need not be stripped beyond the amount required to allow comfortable apposition at the first suture line.

DISCUSSION

The timing of the second stage of this operation may perhaps be discussed briefly. The earliest time at which it is feasible is clearly limited by the time required for a good anastomosis to develop across the suture line, and three weeks is suggested as a minimum. Thereafter any convenient time may be chosen for the completion of the second stage.

Schwann tubes will bridge the lower junction even if the axons have not reached the end of the graft (Young et al., 1940; Sanders and Young, 1942). In the case described by Seddon, Young, and Holmes (1942) it was found that the fibres that had grown down the graft were separated from the peripheral stump by scar tissue and had sprouted out in all directions in the lower junction scar. This was, however, considered to be due to proliferation of fibrous tissue from the distal stump which was somewhat fibrotic at the time of operation, and not to the absence of axons at the time that the suture was performed. The latitude allowed by pedicle grafting should make it possible to eliminate this danger by resection of the distal stump low enough to obtain an ideal face.

The applicability of the operation is recognized as being highly circumscribed. For example, the traction lesion of the brachial plexus and of the lateral popliteal nerve at the knee can hardly be expected to benefit from it. Further, it is essentially dependent, in my view, on there being a double lesion. I would hesitate to emulate Flourens (quoted by Sanders, 1942) and advocate the sacrifice of an *intact* main trunk, even for the median, though I do not think there need be any qualms about using a damaged ulnar or radial for the median, or lateral popliteal division of the sciatic for the medial.

In spite of its limitations I feel that the operation is worth recording now on the grounds that others working in this field might find isolated opportunities for employing it, particularly in Service patients whose injuries might well be too old for any hope of improvement if this report were held up until a final result of the particular case could be given. It is the principle, not the case, that is the reason for this contribution. Obviously it is a principle that is capable of considerable expansion in its application and variation in detail, though it is not possible to suggest them all here.

If this paper simply serves to canalize thought and research into what may prove to be a progressive direction, it will, perhaps, have been of some value.

SUMMARY

A rational pedicled nerve autograft is described, and should surmount many of the problems hitherto associated with nerve-grafting.

In particular, it eliminates a period of ischæmia, whether relative or absolute, so that there need be no cause for anxiety for the fate of the axons during their passage through the graft. As good an upper suture line can be obtained as in direct nerve suture, and there will be properly apposed outgrowing axons and Schwann tubes. There is no loss of regenerating axons into a host nerve-trunk, as in the only previously described 'true nerve pedicle graft'.

It is hoped to submit a follow-up report of the case when the result is known. At present (Nov. 18, 1946) Tinel's sign has steadily advanced as far as the necks of the metacarpals.

My thanks are due to Sir Walter Haward, Director-General of Medical Services of the Ministry of Pensions, for permission to publish this paper, and to Professor H. J. Seddon for his generous advice in its presentation and permission to quote from a paper at present in the press.

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SHORT NOTES OF RARE OR OBSCURE CASES

A CASE OF MYXOMATOUS TUMOUR ARISING IN THE ADVENTITIA OF THE LEFT EXTERNAL ILIAC ARTERY

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SURGEON TO GUY'S HOSPITAL
AND J. A. KEY
ASSISTANT DEMONSTRATOR OF ANATOMY

THE following case is reported because, so far as can be ascertained, no other similar case is to be found in the literature.

CASE REPORT

HISTORY.—The patient, a man aged 40, was admitted to Guy's Hospital on Jan. 27, 1946. For the previous four months he had complained of pain in the muscles of the left leg on exertion. Apart from an attack of

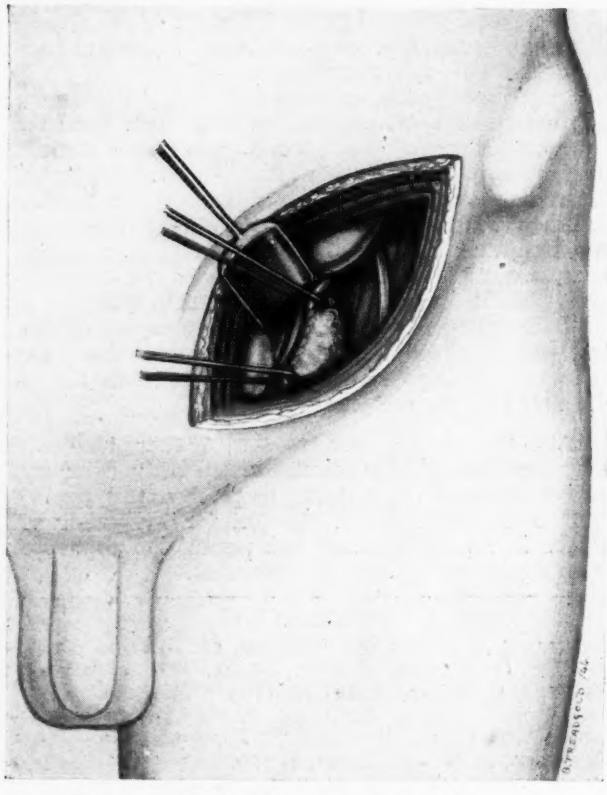

FIG. 577.—Showing the growth on the left external iliac artery.

measles as a child, he had suffered from no other previous illness. One of his brothers had died of pulmonary tuberculosis many years ago.

He was of athletic build, and had served in the Army from 1921 to 1929, when he joined the police force, where for ten years he did foot patrols. He smoked twenty cigarettes a day and was of temperate habits.

History of Present Illness.—For four months the patient had complained of pain in the left leg on exertion. At first the pain came on after he had walked about half a mile, but the condition had progressed in severity, so that at the time of his admission it appeared after walking 100 yards, and after a further 200 yards so incapacitated him that he had to rest. The pain then passed off.

The distribution of the pain had remained constant. The left quadriceps group was first affected, with subsequent spread to the calf muscles and then to the tibialis anterior. It was made worse by cold and wet weather and by the intensity of muscular exertion. Thus he could avoid the pain indefinitely if he strolled gently instead of walking at his usual pace.

Two and a half months before admission, he was diagnosed elsewhere as thrombo-angiitis obliterans and treated by diathermy, with slight improvement. There was no history of trauma.

CONDITION ON ADMISSION.—The patient looked well and was of muscular build.

Cardiovascular System :—
B.P. 120/80, equal in both arms and legs.
Heart—no enlargement or abnormality.
Brachial vessels palpable and normal.
Posterior tibial pulse—readily palpable on both sides.
Dorsalis pedis pulse—readily palpable on both sides.
Both retinæ were normal.
Other Systems : No abnormality could be detected.
Routine Investigations :—
Urine—normal.
Blood W.R. and Kahn both negative.

X-ray examination of heart and chest showed no abnormality, and of pelvis and lower limbs showed no vessel calcification.

Special Investigations on Left Leg.—

1. *On Exercise* :—

a. Pain could be induced by 35 full movements of dorsi- and plantar-flexion against the resistance of a hand applied to the sole of the foot. The distribution of the pain was as previously described.

b. Stepping up and down off a stool 2 ft. high, at the rate of one step every two seconds, produced pain in fifty seconds.

c. When walking on the flat in the warm ward, the sensation of pain was first noted after 98 steps, and after 280 steps the patient had to halt on account of the severity of the pain. The posterior tibial pulse became barely palpable, and the popliteal pulse was diminished while the pain persisted. The limb became increasingly cold and white. Over the base of the femoral triangle, there developed a palpable thrill and an audible systolic murmur.

d. All these phenomena disappeared on cessation of the exercise.

2. *Sympathetic Innervation* :—

a. Spinal anæsthesia, after an initial fall in skin temperature, produced a steady rise over 60 minutes from 28·4° C. to 33·0° C. in both limbs. This was accompanied by flushing.

b. Left paravertebral sympathetic block anæsthesia produced a rise in skin temperature of 2·0° C. in the left limb, accompanied by flushing.

After this last procedure, the exercise test in 1 (*b*) was repeated, and no pain developed after three minutes.

PROVISIONAL DIAGNOSIS.—On the clinical findings, a diagnosis of thrombo-angiitis obliterans (Buerger's disease) was made, and lumbar sympathectomy was advised.

SUBSEQUENT HISTORY.—Admission to the surgical wards was delayed at the patient's own request as he had some business to attend to, and he was eventually re-admitted to hospital six weeks later for operation.

Examination on re-admission revealed that the symptoms were unchanged, but on palpation in the left iliac fossa there was now a painless lump about the size of a golf ball. It was situated above the inguinal ligament in the line of the external iliac artery; it was smooth in outline, non-pulsatile, and slightly mobile from side to side. It was apparently deep to the external iliac artery, and as the radiograph of the pelvic bones was normal and there are no lymph-glands in this situation, it was thought to be a tumour of the psoas or iliacus muscle. In view of these fresh findings, exploration of the external iliac artery was advised.

OPERATION.—The left external iliac artery was exposed through Abernethy's incision, and a small growth, greyish-red in colour, was found arising from the posterior aspect and investing the middle third of the artery (*Fig.* 577). It had a slightly lobulated appearance and was cystic. There was a considerable degree of periarterial fibrosis, which rendered it relatively fixed. The growth was non-pulsatile.

Dissecting the mass off the artery was difficult, and at one point the wall of the artery was ruptured. This was repaired with fine paraffined silk, and the portion of the cyst, which was so intimately incorporated in the artery at this point, had to be left in situ, while the rest was dissected free from the surrounding tissues and removed. The remaining wall was smeared with pure carbolic.

The external iliac artery above and below the lesion was then examined and appeared healthy, as did the accompanying vein. The wound was closed in layers and the skin approximated with clips.

On examining the excised growth it was found to be a typical ganglion containing myxomatous tissue.

POST-OPERATIVE COURSE.—The patient's convalescence was uneventful, and he was discharged in a fortnight. He has remained completely free from symptoms.

Discussion.—It is held that 'ganglia' may occur wherever there is mesodermal tissue, but the appearance of myxomatous degeneration in an artery wall is exceptionally rare, and such a change giving rise to symptoms of intermittent claudication by pressure on the external iliac artery is, so far as we know, unreported. An interesting feature of the case was the palpable and audible thrill which occurred over the diseased portion of the artery after exercise, and the significance of this physical sign was freely discussed when the patient was first admitted to hospital and at a time when, in the absence of a palpable tumour, a diagnosis of thrombo-angiitis obliterans had been entertained. It was then remarked that a thrill had never been noted in this disease before, and a careful investigation was conducted in order to eliminate the possibility of iliac aneurysm.

A CASE OF MESOTHELIOMA OF THE EPIDIDYMIS

BY T. C. PATTERSON, SURGEON CAPTAIN, R.N. (RET.)
AND R. A. MOGG, SURGEON LIEUT.-COMMANDER, R.N.V.R.
SPECIALIST IN UROLOGY

TUMOURS of the epididymis have always been considered by medical writers to be most uncommon and very little has been recorded concerning them. Most text-books on pathology dismiss them shortly with the remark that they are very rare. From time to time, however, isolated groups of cases have been described under a variety of pathological classifications and it was not until the work of Newton Evans (1943, a) was presented, that the pathology of these tumours became clarified. Formerly the terms used in the descriptions represented a pathological miscellany, and such names as lymphangioma, adenocarcinoma, and benign adenoma were used. The following case is presented on account of its interest, and a brief review of the literature as analysed by Evans is appended.

CASE REPORT

C. R., Lt., Royal Marines, was first seen by one of us (R. A. M.) on account of a hard painless swelling of the right epididymis which had been present for one year. The patient only presented himself for examination to ascertain his fitness for foreign service. There was a history of trauma to the right testicle by a hockey ball, approximately six years previously. The swelling which resulted from this trauma, and which was considered to be a hæmatoma of the testicle, subsided completely within a few months of the injury. The present swelling was first noticed accidentally by the patient about one year before examination, and it had gradually increased in size painlessly since that time. There had never been any evidence of a hydrocele, neither had there been any urinary symptoms.

ON EXAMINATION.—There was a small, hard, spherical nodule about an inch in diameter situated in the globus major of the epididymis, without any evidence of involvement of the scrotal skin. There was no hydrocele and no lymphadenopathy. Rectal examination was negative.

AT OPERATION.—Under pentothal, nitrous oxide, and oxygen anæsthesia, the epididymis was exposed through a midline scrotal incision; the tunica vaginalis was normal and did not contain any excess fluid. The tumour was of the size described above, encapsulated in the globus major of the epididymis, while the rest of the epididymis and testicle were macroscopically normal. Right epididymectomy was performed and the wound closed with drainage. Convalescence was normal. Patient was discharged from hospital nine days after operation and has remained entirely fit.

THE SPECIMEN.—This was examined by one of us (T. C. P.) and it was found that there was a hard spherical encapsulated tumour about 2·5 cm. in each diameter, occupying the globus major. The cut surface of the tumour had a faint branching pattern and was smooth, moist, firm, homogeneous, and cream coloured (*Figs.* 578, 579).

Microscopically it showed as a very cellular tumour with only sparse connective-tissue elements, which consisted of strands of fibrous tissue and unstriated

muscle. The cellular parts were loose, there being many empty spaces, apparently lymphatic, and also many globules and vacuoles. The essential stroma consisted of a delicate rarefied network of collagen, suffused with lymphocytes, together with a few eosinophils and plasma cells; in places the lymphocytes were

FIG. 578.—Tumour of head of epididymis as resected. (× $\frac{3}{4}$.)

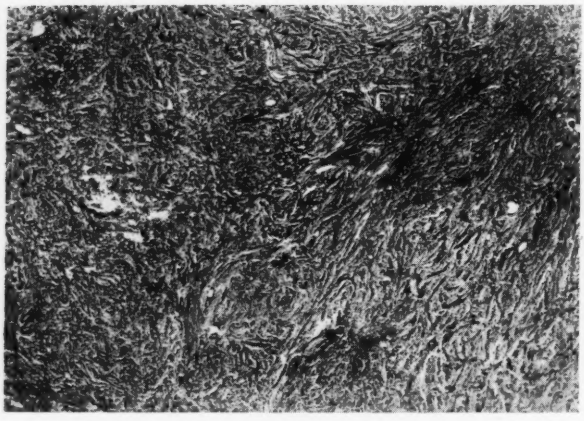

FIG. 580.—Loose interlacing pattern of fine supporting tissue beset with cells and spaces. H. and E. (× 60.)

arranged in denser clumps. The constituent tumour cells were large and polygonal in shape, with abundant non-granular cytoplasm and often containing vacuoles. The nuclei were oval, moderately vesicular, with a distinct nucleolus. These cells occurred in branching sheets or narrow columns with clefts between them, but in places pseudo-acini were seen, which gave the impression of being formed from coalesced vacuoles. Fine capillary vessels were common throughout the section. (This description conformed with the recognized characteristics of a mesothelioma.)

DISCUSSION

The term 'mesothelioma' is given to a tumour which arises from the lining cells of the serous membranes of the various body cavities, and histologists are in agreement that the covering cells of the pleura, peritoneum, tunica vaginalis, and the pericardium constitute a mesothelium, Newton Evans (1943, b) has shown that tumours of identical microscopical structure to mesotheliomata have been

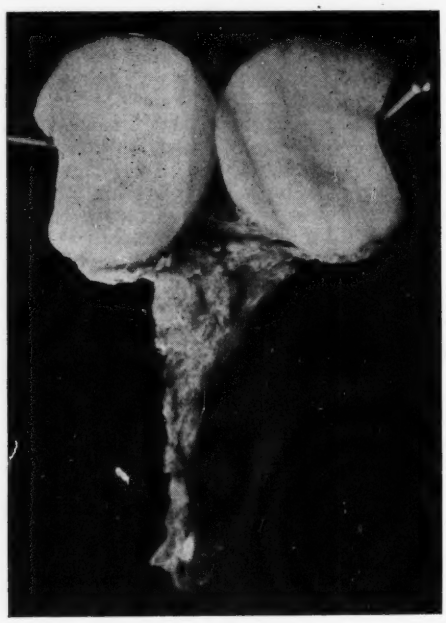

FIG. 579.—Tumour bisected, showing solid homogeneous interior. (Retained as hospital museum specimen.) (× $\frac{5}{6}$.)

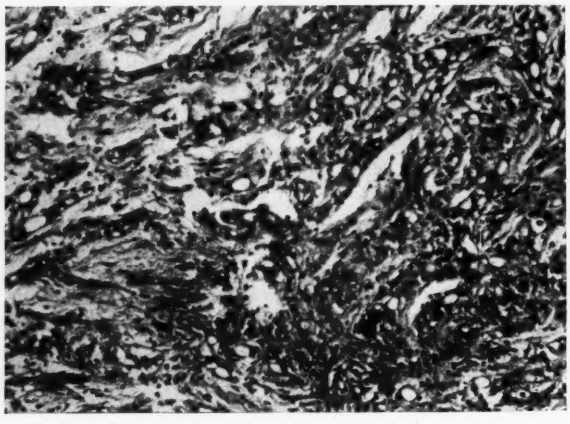

FIG. 581.—Constituent cells—large, clear, polyhedral, frequently vacuolated. Lymphocytes common in the stroma. H. and E. (× 225.)

found to occur on the serous surfaces of the uterus and the Fallopian tubes, and that the cells in the gland-like spaces of the tumour have a direct connexion with the cells covering the serous surfaces of these organs. Therefore it may be assumed that the tumours arising in relation to the tunica vaginalis, having as they do a structure identical with those arising from the female pelvic peritoneum in relation to the uterus and the Fallopian tubes, must have a common origin from the mesothelial cells of the serous membrane. It is possible, then, that these tumours arise from the mesothelium covering the urogenital ridge of the embryo.

It is held by some authorities that somewhat similar growths may be definite adenomata arising from rete testis or more particularly from a remnant of paradidymis.

Mesotheliomata are a group of slow-growing tumours, usually small in size, solitary, and with a well-defined capsule. They are benign in character and can be removed quite easily surgically. They occur most frequently in relation to the lower pole of the epididymis. In the majority of cases there is a history of trauma to the affected part, but it is very doubtful if this is an aetiological factor in the production of these tumours.

Microscopically they present a characteristic appearance and at first sight appear to be adenomata, from the way in which the groups of cells are arranged. The tumour cells in mesothelioma vary in size, shape, and arrangement, ranging from flat plates to a low columnar type. The characteristic feature of the cells is that large numbers of them have a vacuolated cytoplasm and, while many of them are arranged in solid groups, others have a definite adenomatous formation. Another characteristic feature is the presence of numerous lymphoid-like cells scattered throughout the tumour. The microscopical structure of the specimen referred to in this article closely resembles the above description, as can be seen by examination of the photomicrographs (*Figs.* 580, 581).

It is quite evident on careful study of the cases previously reported as adenomata, adenocarcinomata, and lymphangiomata of the epididymis, that the tumours really belonged to the class of mesotheliomata. For instance, in two of the three cases quoted by Thompson (1936), and diagnosed as adenocarcinomata, the patients were alive and well eighteen and twenty years after simple local excision of the respective tumours. Similar results are quoted by Charache (1939) and Newton Evans (1943, a). Gordon-Taylor and Ommaney-Davis (1941) record a case which was designated as " an adenoma, probably from some aberrant cells in connexion with the mesonephric duct ", occurring in relation to the lower pole of the epididymis, which was treated by orchidectomy with complete recovery. The adenoma of Blumer and Edwards (1941) was of much the same nature as the foregoing. It occurred in a man aged 54, and was made up of tubular formations lined by cubical to flattened epithelium simulating epididymal structure ; lymphocytes were scattered in the stroma. The growth had been present since boyhood, was easily dissected away from the otherwise healthy testis and epididymis, and recovery was uneventful.

We tender thanks to Surgeon Vice-Admiral H. St.C. Colson, C.B.E., Medical Director-General, Royal Navy, for approval to submit this contribution for publication.

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PENETRATING CHEST WOUND WITH LODGEMENT OF THE FOREIGN BODY IN THE COMMON BILE-DUCT

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SURGICAL REGISTRAR TO AN E.M.S. CHEST UNIT

THIS case is thought worthy of record not only because it may be unique, but also because of the interesting problem of diagnosis involved.

CASE REPORT

A. B., aged 19 years, was wounded by a mortar bomb explosion in Normandy on June 28, 1944. The entry wound was in the right lower chest in the posterior axillary line, and there was no exit wound. A laparotomy performed the day after wounding on account of upper abdominal pain and tenderness revealed a small hole in the right diaphragm and a laceration in the superior surface of the liver. There was no other visceral damage, and the wound was closed without drainage. Apart from a temporary collapse of the right lower lobe, he progressed quite satisfactorily until July 14 (16 days after wounding), when he developed acute epigastric pain and vomited on several occasions. The next day he developed signs of consolidation at the right base and began to cough up bile-stained sputum, which on bronchoscopy was seen to be coming from the right main bronchus.

When admitted to this Chest Unit a week later, he was a very ill man, coughing up over ½ pint of heavily bile-stained sputum daily, and with signs of consolidation over most of the right lung. An X-ray picture of his chest showed an area of increased opacity in the right lower lung field, a fluid level in the lower axillary region, and a metallic foreign body apparently deep in the substance of the liver. In order to prevent his continued expectoration of bile with its irritating effect on the lung, a portion of the 8th rib was resected in the posterior axillary line, and a small pleural space opened. A bronchial fistula into the lower lobe was seen and, in addition, there was a sinus leading through the diaphragm into the right lobe of the liver. It was not possible to feel the foreign body in the liver substance, so two tubes were inserted, one into the liver, and one into the empyema cavity (*Fig.* 582).

The sputum continued to be a little bile-stained for two weeks, but there was an immediate reduction in the amount of bile present, and within a month the lung had cleared completely. There was still a bronchial fistula present, however, and it was decided that an attempt should now be made to close it ; subsequently the liver could be explored in order to remove the foreign body. This closure was effected by suturing a flap of latissimus dorsi over the fistula. The sinus leading into the liver was dilated with bougies, and although it was then possible to feel the foreign body, the track was too long and narrow to remove it with safety by this route. A small-bore rubber drainage tube was inserted into the sinus, and a gauze pack placed in position between the muscle-graft and the tube. The graft took successfully and the fistula was obliterated, thus leaving the patient with a sinus in the lower chest, from which bile discharged in varying amounts.

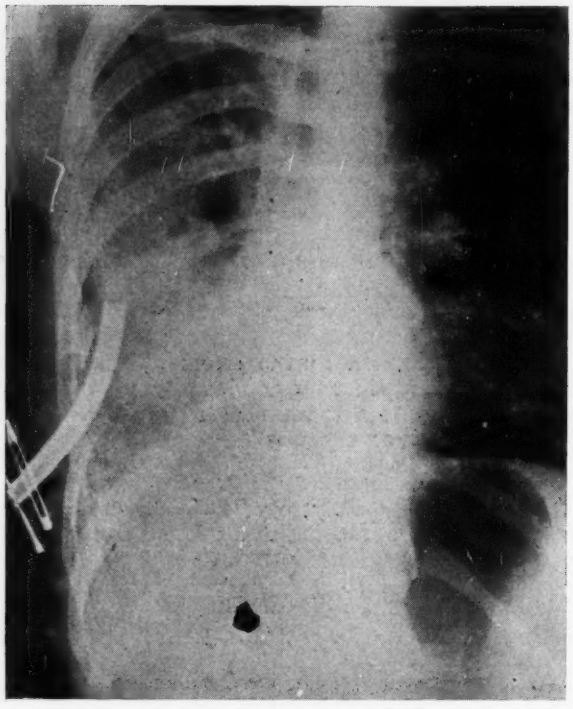

FIG. 582.—Radiograph one week after rib resection, showing biliary pneumonia, bomb fragment, and drainage tube in empyema cavity (the tube leading into the liver was not a barium tube, and so cannot be seen).

FIG. 583.—Radiograph after introduction of lipiodol into liver sinus, showing a short wide channel (the common bile-duct) stopping abruptly at the bomb fragment. The narrow shadow overlying the last rib is due to lipiodol in a hepatic duct.

On several occasions the patient complained of right upper abdominal pain, and at the same time the stools became clay-coloured. He did not become jaundiced during these attacks, nor was any gall-bladder or liver enlargement detectable, but it was noticed that there was an increased amount of biliary discharge from his chest sinus. This picture of abdominal pain and pale stools bore a striking resemblance to that seen in obstruction of the common duct by a calculus. An X-ray picture after lipiodol had been introduced into the chest sinus showed a short wide channel filled with oil which stopped abruptly at the foreign body (*Fig.* 583). This shadow was in a position compatible with its being the common bile-duct, and these appearances, combined with the clinical picture, made us feel that the foreign body must be actually in the common bile-duct, and so causing its intermittent obstruction.

A laparotomy was performed on Jan. 11, 1945, just over six months from his initial injury, and a piece of metal $\frac{1}{2} \times \frac{1}{4} \times \frac{1}{4}$ in. was palpated in the common bile-duct just below the point of entry of the cystic duct. The duct was incised and the piece of metal was removed. After sucking out a fair quantity of biliary mud, a catheter was passed up and down the common duct to confirm its patency. The common duct was sutured around a T-tube and the abdomen closed with a corrugated rubber drain going down to the neck of the gall-bladder. The patient subsequently made an uninterrupted recovery. The T-tube was removed after two weeks, his stools became a normal colour, and both his chest and abdominal wounds rapidly healed. When seen a year later he remained perfectly well except for a slight unproductive cough.

Comment.—The main interest of this case lies in the final position of the foreign body, which came to rest in the common bile-duct, having penetrated the chest and traversed the diaphragm and liver. In this situation it periodically caused an obstruction to the flow of bile into the duodenum which was unaccompanied by jaundice because the sinus through the diaphragm to the empyema drainage site provided a safety-valve mechanism through which the bile was able to discharge. An increase in the flow of bile from the chest sinus was very noticeable whenever the patient developed upper abdominal pain, and each time following this the stools became clay-coloured. The absence of any enlargement of the gall-bladder or liver was confirmed at operation.

The extremely irritating effect of bile on the lung substance was well shown by his condition on admission, and this biliary pneumonia rapidly resolved following the insertion of a drainage tube into the pleural cavity, with the resulting almost complete cessation of biliary expectoration. Although bronchography has not been performed, clinical examination and radiography revealed no permanent pulmonary damage.

It is considered probable that the foreign body initially lay in one of the hepatic ducts, and subsequently descended to its final position. Had the piece of metal penetrated the common duct, there would almost certainly have been evidence of this at operation, but in actual fact there were no adhesions around the common duct, nor any evidence of its having been injured.

I should like to express by thanks to Mr. O. S. Tubbs for permission to write this account, and for his very valuable assistance in its preparation; also to Dr. B. G. Wells for the photographs.

TRAUMATIC PARARENAL PSEUDOHYDRONEPHROSIS

REPORT OF A CASE

By B. E. CRAWFORD STANLEY

TRAUMATIC pararenal pseudohydronephrosis, or, as it has been variously called, hydrocele of the kidney, hydroperinephrosis, renal hygroma, or perirenal hydronephrosis, is an uncommon condition to which few references have been made in British medical literature.

Crabtree (1935) presented a full account of the condition and described a number of cases of his own and other surgeons. In the majority of the cases described the patient was either not cured or suffered the loss of the affected kidney. Woodruff and Rupert (1939) mention the possibility of preserving the kidney as being unlikely, but say that it might be done in the case of a small cyst. In the case described below a large cyst was satisfactorily removed. The affected kidney was not excised, but it was subsequently found to have some impairment of function.

CASE REPORT

HISTORY.—J. P., a man 23 years of age, gave the following history: Six weeks previously he had been involved in a car accident and sustained a lacerated forehead, a small fissured fracture of the left frontal bone, fractured right transverse processes of the 3rd and 4th lumbar vertebræ, and a closed lesion of the right kidney. After this injury he had hæmaturia for about a week. He had made good progress but was not yet discharged from hospital.

He complained of increasing pain in the right loin of about a week's duration. The pain was continuous, but not severe, and it did not radiate.

ON EXAMINATION.—His general condition was good. His temperature rose each evening to about 100·5°, but he had very little constitutional upset. There was a large tumour in the right loin. This tumour extended forward to the umbilicus and downward to the anterior superior spine. It was slightly tender.

Investigations :—

Urine: A few pus and epithelial cells. Sterile on culture.

Blood-urea: 27 mg. per 100 c.c.

White blood-cells: 7800 per c.mm. Differential count normal.

Barium enema: Ascending colon displaced anteriorly and toward the midline.

Intravenous pyelogram: Left kidney functions normally; no excretion from right kidney.

Cystoscopy: The bladder appeared normal, but no efflux was seen from the right ureter. A ureteric catheter passed up the right ureter was obstructed at the level of the 4th transverse process. An attempt to inject sodium iodide resulted in regurgitation of the fluid into the bladder along the side of the catheter. When the force of the injection was increased a very little sodium iodide solution passed into the kidney, but not enough to show the outline of the pelvis (*Fig.* 584).

OPERATION.—Under general anæsthesia an oblique incision was made in the loin. The tumour was found to be a large cyst containing urine and was situated on the anterior and lateral aspects of the right kidney. The cyst wall was about ½ in. thick and consisted of dense fibrous tissue with a smooth lining. After the cyst had been opened widely, the kidney was seen lying in its medial wall, and it was possible to dissect the cyst wall away piecemeal. An apparently healthy kidney remained, stripped of its capsule on its anterior and lateral aspects. Urine was seen to be leaking through a small hole in the lower pole of the kidney. A drainage tube was inserted and the incision in the loin closed in layers.

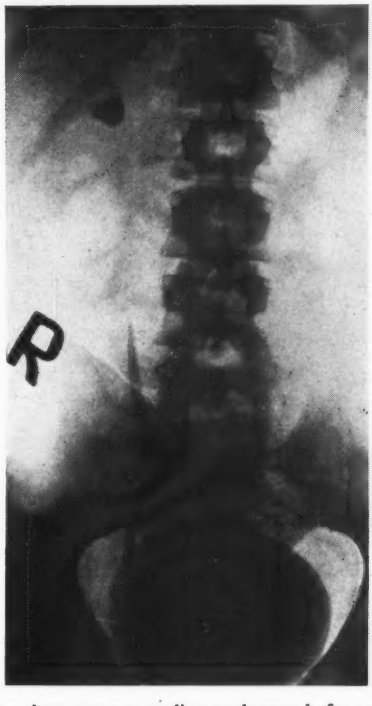

FIG. 584.—Attempt at ascending pyelogram before operation.

PROGRESS.—After operation the wound discharged urine freely, necessitating very frequent dressings.

On the fifth day after operation cystoscopy was performed, and a ureteric catheter was passed easily up into the right renal pelvis. On injection of sodium iodide the pelvis was shown to be dilated and there was a leak through the inferior calix into the perirenal tissues (*Fig.* 585). The ureteric catheter was left in position for twelve hours and during this time several ounces of urine drained through it. After the removal of the catheter the wound in the loin dried up very quickly. The tube was removed on the eighth day after operation and the wound was soundly healed by the fourteenth day.

Four weeks after operation the patient was very well and had no symptoms. An intravenous pyelogram showed slightly delayed excretion from the right kidney, which had a mild degree of hydronephrosis (*Fig.* 586).

DISCUSSION

The pathogenesis of the condition is a rupture of the kidney which involves the renal pelvis. A hæmatoma in the perirenal fat develops, and into it there is a leak of urine. The rupture in the kidney substance fails to heal and the escape of urine continues into the cavity of the organizing hæmatoma

which is bounded by the perirenal fat and the fascia of Gerota. The absence of perirenal fat which is found at operation on these cases is reported as a regular occurrence and indicates that the cyst is formed in this layer (Johnson and Smith, 1941). An essential factor in the formation of the cyst is the existence of ureteric obstruction. This may be due to pressure of extravasated blood that occurs at the time of the original injury or to an intra-ureteric clot. This has been proved by the experimental production of similar cysts in animals (Razzaboni, 1922).

FIG. 585.—Ascending pyelogram five days after operation, showing leak through the lower calix. Drainage tube in position.

FIG. 586.—Intravenous pyelogram four weeks after operation.

SUMMARY

1. A case of pararenal pseudohydronephrosis is described.

2. Factors concerned in the formation of such cysts are trauma involving the calix of a kidney, delayed healing of the kidney, and ureteric obstruction.

3. Removal of the cyst was possible with preservation of the kidney, which showed some impairment of function.

I wish to express my thanks to Capt. J. C. Fulford, R.A.M.C., for his help in the management of this case.

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EXOSTOSIS OF THE CORONOID PROCESS OF THE MANDIBLE AND TRUE JOINT FORMATION WITH ZYGOMATIC ARCH

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CASE REPORT

The patient, a male aged 18, was referred to me complaining of swelling of the left cheek which had been present for about two years. He had a history of having been struck on the cheek some months previously by a cricket ball, but this was after the swelling had started.

ON EXAMINATION.—A bony hard swelling of the cheek was apparent; portions of the swelling appeared to move when the mandible was moved. There was a slight limitation of movement of the mandible in all directions; nothing could be felt from inside the mouth. (*Fig.* 587.)

Radiographs were taken and revealed an exostosis of the coronoid process of the mandible with expansion of the zygomatic arch. In view of the gradual increase in size it was decided to excise the exostosed coronoid process.

AT OPERATION (Mr. Robert Kennon).—The zygomatic arch was divided in two places 1 in. apart over the swelling,

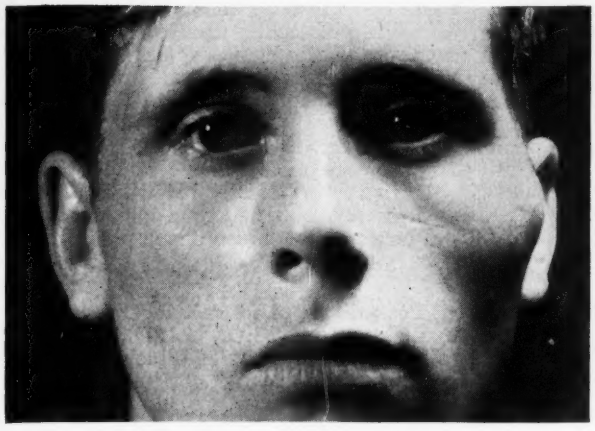

FIG. 587.—Photograph showing the swelling of the cheek.

FIG. 588.—The exostosis.

and on raising it up the appearance of a true joint was revealed. The coronoid was divided below the exostosis with bone shears and was shelled out readily. The zygomatic arch was replaced and the wound was closed.

The patient made an uneventful recovery and was discharged from hospital one week later.

Fig. 588 depicts the exostosis; on section it was indistinguishable from bone, with a healthy and normal joint surface. A post-operative radiograph revealed a still slightly enlarged coronoid.

REVIEWS AND NOTICES OF BOOKS

Ambulatory Proctology. By ALFRED J. CANTOR, M.D., Associate Proctologist, Kew Gardens General Hospital, Long Island, New York. With a Foreword by BEAUMONT S. CORNELL, M.D., Editor, *American Journal of Digestive Diseases*. 9 × 6⅛ in. Pp. 524 + xviii, with 281 illustrations. 1946. London: Hamish Hamilton Ltd. 42s. net.

THIS new work provides a good deal of interest, particularly from the aspect of diagnosis. Many of the operations recommended as ambulatory procedures, such as hæmorrhoidectomy, fistulectomy, excision of the coccyx and pilonidal sinuses, and various operations for prolapse, as well as plastic procedures for anal incontinence, are in this country considered to be better treated by formal operations with in-patient care. Those with experience of rectal work will, however, gain some fresh ideas by reading this book even if they do not approve of much that is recommended. The injection methods are well described, and, of course, anal papillæ and cryptitis receive their due measure of attention.

The middle section of the book, Chapters XIII to XXIII, on colitis, dysentery, tuberculosis, parasites, and venereal diseases affecting the rectum and anus, are sound and up to date.

The illustrations are large, clear, and well chosen. A useful bibliography is given to each chapter.

Renal Diseases. By E. T. BELL, M.D., Professor of Pathology in the University of Minnesota, Minneapolis, Minnesota. 9⅛ × 5¾ in. Pp. 434, with 115 illustrations and 4 coloured plates. 1946. London: Henry Kimpton. 35s. net.

THIS monograph is the result of twenty-five years' study of the pathology of renal diseases, and the author is to be congratulated on the vast amount of new work which is incorporated in the volume. Of necessity, the accumulated knowledge of a quarter of a century in any keen and active investigator must be fruitful, for such a man can impart knowledge in a mellowed and constructive form. This is what we find in this book. The author discusses the structural changes in the kidneys, the pathological physiology, and the clinical manifestations of different diseases. The relation of hypertension to the kidneys is discussed fully, and there is a discussion of the toxæmias of pregnancy and the renal lesions in diabetes. New growths of the kidney receive adequate notice.

The surgeon of to-day must know more and more about medicine and pathology and this book should prove of real value to the practical surgeon. The closer the co-operation between clinician and pathologist, the better for the future of medicine in all its branches.

L'Ostéosynthèse au Clou. By R. SŒUR, Chirurgien-Adjoint des Hôpitaux de Bruxelles. 9½ × 6¾ in. Pp. 132, with 134 illustrations. 1946. Paris: Masson et Cie. 325 fr.

THIS book is an account of methods of treating fractures by the introduction of nails.

The methods described include the introduction of a bar of steel into the medullary cavity of long bones, and the removal of the bar after consolidation of the fracture.

Another method is the classical one of the Smith-Petersen pin for fractures about the neck of the femur. Then there is a new and original method, according to the author hitherto unpublished, which describes the treatment by a nail with a double hook. This is designed to surmount some of the shortcomings found in methods previously described.

Thromboses arterielles. Physiologie pathologique et Traitement chirurgical. By RENE LERICHE, Professeur au Collège de France, with the collaboration of D'IVAN BERTRAND, Directeur de l'Institut de Neurobiologie à la Salpêtrière. 9 × 5½ in. Pp. 537 + viii, with 59 illustrations. 1946. Paris: Masson et Cie. Fr. 600.

THIS book may be regarded as the author's collected work on the pathological physiology of vascular disease and the syndromes of causalgia, muscular contracture, œdema, ischæmic necrosis, and pain which are associated with vasomotor disorders. Though arterial thrombosis, its causation, evolution, and effects, acts as a framework for the complete structure of the book, Leriche has built

so much on to it that the title of the work is such an understatement of its scope as to be almost misleading.

The early pages deal with the pathology of arterial thrombosis in general, and certain laws are enunciated which regulate the behaviour of clots, and the ischæmic phenomena produced by them. The rest of the book is divided into three parts. First, traumatic thrombosis due to contusion and rupture of arteries is considered, with the treatment of Volkmann's contracture and ischæmic necrosis. The second part deals with spontaneous thrombosis occurring in obliterative arteritis, and it is of special interest that pathological changes in the sympathetic ganglia are described which may be of aetiological significance in certain forms of structural disease of the arteries. Treatment by conservative measures, adrenalectomy, sympathetic ganglionectomy, and amputation are considered in full, and a special plea is made for further research directed to establish the proper role of adrenalectomy, since Leriche suggests that the secret of arteritis may lie in the endocrine system. In the third part he describes thrombosis in vessels other than those of the limbs—the abdominal aorta, and the coronary arteries—which affords an opportunity for a discourse on the treatment of angina pectoris.

It is not easy to review so large a work in a few sentences, but enough may have been said to indicate that this is really the confession of faith of a great surgeon who will long be remembered for the originality and enthusiasm which have enabled him to contribute so much to the elucidation and treatment of vascular disease.

A Synopsis of Surgical Anatomy. By ALEXANDER LEE MCGREGOR, M.Ch. (Edin.), F.R.C.S. (Eng.), Surgeon, Johannesburg General Hospital; Lecturer on Surgical Anatomy, University of Witwatersrand. With a Foreword by Sir HAROLD J. STILES, K.B.E., F.R.C.S. (Edin.). Sixth edition. $7\frac{1}{4} \times 4\frac{7}{8}$ in. Pp. 714 + xvi, with 699 illustrations. Bristol: John Wright & Sons Ltd. 25s. net.

THIS book is already firmly established as one which deals with anatomy from a surgical as well as an academic aspect. It probably contains more anatomical detail useful to the surgeon than any other of its kind. The sixth edition contains a revised account of Volkmann's contracture; whilst pressure is admitted as a possible cause more stress is placed on vasoconstriction due to sympathetic injury. The functions of the nerves supplying the urinary bladder are also discussed on more modern lines, the theory of sympathetic and parasympathetic antagonism being rejected for this viscus and recognition being accorded to the paramount importance of the parasympathetic for storage and evacuation of urine.

The student with a good knowledge of topographical anatomy will find here the way in which to develop and apply it.

Minor Surgery (Heath: Pollard: Davis: Williams). For the Use of House Surgeons, Dressers, and Junior Practitioners. By CECIL FLEMMING, O.B.E., M.Ch., F.R.C.S., Surgeon, University College Hospital With a chapter on The Administration of Anæsthetics by H. N. WEBBER, B.Ch., D.A., Anæsthetist, University College Hospital. Twenty-third edition. $7\frac{1}{4} \times 4\frac{3}{4}$ in. Pp. 406 + viii, with 209 illustrations. 1946. London: J. & A. Churchill Ltd. 14s. net.

THERE is no need to praise a book which has survived for eighty-six years and reached twenty-three editions. The foundations laid by Christopher Heath have proved lasting, and the superstructure added by subsequent surgeons of University College Hospital has maintained the tradition of good craftsmanship. There are one or two minor points in which improvements could be effected; the diagrams on p. 32 of a ligature being tied with forceps would be more easily followed if one end of the ligature was held in dissecting forceps, as is usually the case in practice. The kidney position on p. 23 is shown with the lower leg extended and the upper flexed, the opposite of that described by Thomson-Walker, and a position which allows of rotation. The method of suprapubic drainage of the distended bladder "immediately above the symphysis pubis" is one which leads to difficulties in the later treatment. Nevertheless, this volume is one which every house surgeon should possess and read; it will help to smooth his difficult path.

The Surgical Technic of Abdominal Operations. By JULIUS L. SPIVACK, M.D., LL.D., Associate Professor of Surgery, University of Illinois College of Medicine. Fourth edition. $9\frac{7}{8} \times 6\frac{5}{8}$ in. Pp. 709 + xvi, with 362 illustrations. 1946. Springfield, Ill.: Charles C. Thomas. $10.00.

THE fourth edition of this volume has been thoroughly brought up to date and new material has been added. The technique of abdominal operations appeals to a vast number of surgeons, for the abdomen is practically the only part of the body which is left for the general surgeon.

The illustrations are of a high order and should be a stimulus for medical illustrations in this country. Every type of abdominal condition is dealt with in a masterful way, and we have nothing but praise for this book.

Injuries of the Knee Joint. By I. S. SMILLIE, O.B.E., M.B., F.R.C.S. (Edin.), F.R.F.P.S., Surgeon-in-Charge, Orthopædic Hospital, Larbert, Stirlingshire (Scottish E.M.S.). $9\frac{5}{8} \times 6\frac{7}{8}$ in. Pp. 320 + xi, with 350 illustrations. 1946. Edinburgh: E. & S. Livingstone Ltd. 35s. net.

CONSIDERING the rather limited subject this is a large book, but it is based on a very extensive experience gained over a period of five years at an Orthopædic Unit of a Base Hospital during the late war. In the preface the author draws attention to the very large number of such injuries which are incidental to military training and to the associated athletic activities. The book is based on personal experience and does not claim to represent a complete review of the extensive literature of the subject. Most of the excellent illustrations are the product of the author's own camera and pen, and in this respect he has made good use of his opportunities. The result is a book which will be valuable to those with sufficient experience to enable them to peruse its pages with discernment. It is scarcely a book for the beginner, though most valuable lessons are to be found in its pages like the reiterated advice with regard to the importance of the functional end-results and the methods by which they can be obtained, and especially the necessity for continuity in treatment. Some of the chapter headings give a good indication not only of the scope of the work but of the author's approach to the problems concerned, viz.: "The importance of the quadriceps", "The Surgical Anatomy and Physiology of the Menisci and Mechanism of their Injuries", "Injuries of Extensor Apparatus", "The Stiff Knee", and so on. Although the author adopts the old-time designation of "Internal Derangement of the Knee-joint" it is rather sad that there is no mention of Hey, of Leeds (1736–1819), the great pioneer in the elucidation of this disability, who taught us so much about the condition before the days of anæsthesia, X rays, or asepsis. Few surgeons are agreed about the best method of removal of the menisci, but the public have decided that the operation is worth while, so that we are bound to agree that there are many methods of attaining a satisfactory result. The operative management of the ruptured crucial ligaments is fully described but with rather more confidence than past experience would seem to have

justified, though the author does stress the need of longer and more detailed observation of the after-results.

The section on fracture of the patella does not deal sufficiently with the after-care and lacks the details of after-results which would be so interesting and important.

The concluding chapters, dealing with fractures about the joint, affections of bursæ, the stiff knee, and certain other injuries, are interesting and suggestive. In a subsequent edition more information about after-results will very much add to the value of the work.

Surgical Treatment of the Motor-Skeletal System. By 43 authors. Supervising Editor: FREDERIC W. BANCROFT, A.B., M.D., F.A.C.S., Associate Clinical Professor of Surgery, Columbia University; etc. Associate Editor: CLAY RAY MURRAY, M.D., F.A.C.S., Professor of Orthopedic Surgery, College of Physicians and Surgeons, Columbia University; etc. In two volumes. 10 × 6⅞ in. Vol. I: Deformities, Paralytic Disorders, Muscles, Tendons, Bursæ, New Growths, Bones, Joints, Amputations. Pp. 641 + xix, with 521 illustrations. Vol. II: Fractures, Dislocations, Sprains, Muscle and Tendon Injuries, Birth Injuries, Military Surgery. Pp. 671 × xix, with 543 illustrations. 1946. Philadelphia and London: J. B. Lippincott Co. £6.

THE first of these volumes is devoted to general orthopædics and amputations; the second is concerned with injuries and includes a section on war surgery. There are no less than forty-two contributors, all distinguished American surgeons (and one Canadian), and their writings together cover over 1200 pages. In spite of its size it is not altogether a work of reference; descriptions of methods of treatment in vogue outside the United States are not very frequent; it could hardly even be claimed that American orthopædic practice in general is faithfully portrayed, since some of the contributions are very personal. The particular value of the book lies mainly in its breadth of scope, which is not confined to operative surgery, though the latter undoubtedly dominates the picture.

One fault is so glaring that it must be mentioned immediately—the obtrusiveness of the editor. There may have been editors who mistrusted their contributors more, but few can have given such clear and frequent expression of their lack of confidence. In almost every chapter there are longer or shorter paragraphs in brackets—written by the editor—supplementing, correcting, apologizing for, or commending what the particular contributor has written. It is as if the producer of a play were constantly rushing on to the stage and telling the audience that he, and not the actor before them, would show how the lines should be spoken. Here is the editor in a patronizing mood (p. 101, congenital dislocation of the hip): "the following excellent brief résumés of theoretical etiology, embryology, anatomy, and signs and symptoms are allowed here to stand since their bearing on treatment, rationale, and prognosis and on interpretation of results, while in many instances not direct, is nevertheless definite." Why not leave the reader to judge the relevance or otherwise of the obviously excellent passage that follows? The editor could have applied himself rather more profitably to maintaining a proper balance between the various sections and eliminating the more obvious contradictions. In Volume I 40 pages are devoted to an excellent section on amputations; there is then a separate section of about the same length on amputation in diabetes and vascular disease with much vain repetition. Much of the chapter on war surgery is concerned with army medical administration, and where clinical matters are discussed there is a wholly irrelevant section on gas warfare. Other examples of editorial insufficiency are the appearance of discussions of those soft-tissue lesions known variously as subdeltoid bursitis, rupture of the supraspinatus, and Codman's shoulder on p. 312, in another section on p. 320, and yet again on p. 436. On p. 139 one learns that the removal of a wedge from the tarsus is not necessary in cases of acquired pes cavus. Yet in the section of poliomyelitis (p. 229) we are told how to do it and the operation is positively recommended. The clue to this puzzle is found on p. 138, where it appears that one of the writers concerned recognizes three kinds of pes cavus, congenital, paralytic, *and* acquired.

These faults are those of the work as a whole. The individual contributions are excellent and a number of them outstanding; von Lackum's section on the surgical treatment of scoliosis is a masterpiece; almost equally welcome is the chapter by McKittrick and Pratt on amputations in diabetes and vascular disease; A. G. Davis's chapter on injuries of the spine contains all essentials with just the necessary detail; Gordon Murray on injuries of the carpus is at home in a field of which he has made himself master. Not all, but many, of the other sections attain nearly the same standard as those mentioned, and considered as a collection of essays, this large—and expensive—work must therefore be considered a success. If, as we hope and think likely, a second edition is called for, a very heavy responsibility rests on the editor to knit the various sections more closely together and himself to retire into the background.

The 1946 Year Book of General Surgery. Edited by EVARTS A. GRAHAM, A.B., M.D., Professor of Surgery, Washington University School of Medicine; etc. 7 × 4¾ in. Pp. 679, with 213 illustrations. 1947. Chicago: The Year Book Publishers. (London: H. K. Lewis & Co. Ltd.) 21s. net.

EVERY surgeon is interested in this little annual volume which Professor Evarts Graham edits with such skill. As year passes year the work of the general surgeon appears to increase in spite of the fact that many special departments of surgery have been taken away from him. General surgery still covers a wide field and the yearly production of published papers is ever increasing, and it is a real pleasure to read the fascinating précis that Graham has written of all new operations and forms of treatment. It is interesting to see that there is vogue and fashion even in surgery and that new operations are mere modifications at times of so-called old-fashioned techniques. More and more heroic operations are performed on the pancreas, and bowel, and all these are mentioned and given their proper place in this volume.

A most useful book containing a fund of interesting material.

Confrontations radio-anatomo-cliniques. Publiées sous la direction de M. CHIRAY, R.-A.GUTMANN, et T. Sénèque. Fasicule I. 12½ × 9¾ in. Pp. 56, with 98 illustrations. 1946. Paris: G. Doin et Cie, Masson et Cie. 370 fr.

HERE is a volume, the first instalment of a series, of unrelated problems of gastro-enterology illustrated by radiographs and drawings.

Diagnosis and Management of the Thoracic Patient. The American Practitioner Series. Edited by CHARLES PHILAMORE BAILEY, M.D. 9 × 6 in. Pp. 334 + ix, with numerous illustrations. 1946. Philadelphia and London: J. B. Lippincott Co. 24s. net.

THIS symposium of articles on modern surgical practice in the management of the more important diseases of the intrathoracic organs is designed for the general practitioner and general physician, but it is sufficiently specialized to be of more value to the chest expert. It is a useful

book both for reading and reference and contains several outstanding articles, notably those on " Pulmonary Resection for Tuberculosis ", by C. P. Bailey; " Primary Bronchogenic Carcinoma ", by A. Ochsner J. L. Dixon, and M. De Bakey; and " Transthoracic Gastrectomy and Esophagectomy for Carcinoma of the Stomach and Esophagus ", by R. H. Sweet.

Urologic Roentgenology. By MILEY B. WESSON, M.D., Ex-President, American Urological Association. Second edition, thoroughly revised. 9½ × 5⅞ in. Pp. 259, with 258 illustrations. 1946. London: Henry Kimpton. 27s. 6d. net.

THIS second edition reflects the advances made in urography; it has been largely re-written and the illustrations brought up to date. It is not merely an atlas of urological radiographs, for the text is most illuminating and presents the accumulated wisdom of years of experience. In style it is both informative and entertaining, and it abounds in practical tips.

To be dogmatic is to invite criticism; we cannot agree with the statement that excretory urography is valueless in renal tuberculosis and the subsequent account of this condition makes us feel that the author himself does not believe it either.

The chapter on technique gives an indication of the thoroughness with which the information has been collected. It seems unfortunate that the American practice is to cut the right ureteric catheter obliquely for identification, and the left at right angles. The French slogan: " Droit est droit, gauche n'est pas droit ", which is prominently displayed in some French clinics, is more easily remembered.

The numerous illustrations cover the whole field of urology, and the production is excellent.

BOOK NOTICES

[The Editorial Committee acknowledge with thanks the receipt of the following volumes. A selection will be made from these for review, precedence being given to new books and to those having the greatest interest to our readers.]

A Synopsis of Anæsthesia. By J. ALFRED LEE, M.R.C.S., L.R.C.P., M.M.S.A., D.A., Consultant Anæsthetist to Southend General Hospital; etc. 7¼ × 4⅞ in. Pp. 254 + viii, with 42 illustrations. 1947. Bristol: John Wright & Sons Ltd. 12s. 6d. net.

L'Anesthésie intra-veineuse au Pentothal-sodium. By ERNEST KERN. With a Preface by R. MERLE D'AUBIGNE. 7⅞ in. × 5¼ in. Pp. 94. 1946. Paris: Masson et Cie. Fr. 100.

Chirurgie de la Main. By MARC ISELIN, Chirurgien de l'Hôpital Américain. 9¾ × 6⅜ in. Pp. 360, with 135 illustrations. 1946. Paris: Masson et Cie. Fr. 600.

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